2008

Mississippi Department of Transportation (MDOT)

SURVEY MANUAL

The purpose of this manual is to define the minimum specifications and procedures that shall be followed while performing surveys for MDOT by MDOT surveyors or contract consultant surveyors. It is also designed to provide uniformity in surveys preformed for MDOT.

Table of Contents

1.0 Document Objectives

1.1 MDOT's Mission Statement

The Mississippi Department of Transportation is responsible for providing a safe intermodal transportation network that is planned, designed, constructed and maintained in an effective, cost efficient, and environmentally sensitive manner.

1.2 Purpose and Authority

This manual was designed as a replacement to the 1998 MDOT Survey Manual due to changing surveying technology and the needs of MDOT. The principal purpose of this manual is to secure an optimum degree of statewide uniformity in surveying procedures, to establish and maintain survey standards, and to improve the overall efficiency of the Department's survey function. The manual was created by an active committee comprised of representatives from each District, Roadway Design, Bridge, Right of Way, Contract Administration, and Construction divisions.

A legal standard for surveys is not established or intended by this manual.

The Manual does not establish any legal or administrative interpretations of the Department's contracts. In the case of a conflict between the requirements of this manual and the requirements of the contract documents, the contract document shall take precedence.

APPROVED FOR DISTRIBUTION

Deputy Executive Director/Chief Engineer — Date

2.0 Safety Information

Most people who have ever experienced an accident tend to have one thing in common – they believed it could not happen to them. A meaningful safety program requires that each MDOT survey employee clearly acknowledge that

"IT CAN HAPPEN TO ME."

Therefore each person must ask "What is my responsibility?" And "What can I do to lessen my chances of being in an accident?"

This chapter provides a compact source of the basic specifications and responsibilities for safety and health that will aid in preventing accidents and personal injuries while performing field surveying by MDOT or contractor or consultant surveyors. It was compiled from various safety publications distributed by federal, state, and private agencies or firms.

All traffic controls shall comply with the "*Manual on Uniform Traffic Control Devices*".

2.1 Safety Responsibilities for all Survey Operations

Only you can be primarily responsible for your own safety. Hopefully through your attentiveness to recognize and report unsafe conditions, and through the use of this manual and other manuals referenced herein, you may safely complete your surveys.

2.1.1 Individual Responsibilities

- Employees, first and foremost, are responsible for their own personal safety.
- Employees need to be alert for possible unsafe conditions and/or unsafe acts, and should report unsafe conditions and/or acts to the supervisor or acting party chief, in charge.
- Employees shall promptly report all incidents, accidents, and personal injuries to their supervisor after rendering or finding aid for injured persons.
- Employees who fail to comply with safety and health policies, procedures, regulations, laws, or rules shall be subject to disciplinary action in accordance with the provisions described in the *Mississippi State Employee Handbook*.
- Employees must report for work properly dressed to protect themselves from exposure to conditions found on the work site. Garments that expose upper body parts (midriff and shoulders) and bare legs are prohibited. Employees shall wear appropriate footwear for the assigned task and work area.

2.1.2 Personal Protective Equipment

Every survey employee will use/wear personal protective equipment at all times while on the job. The following list identifies types of Personal Protective Equipment that should be used while performing field surveying.

- Hard Hat – Employees must wear hard hats during any work activity that may expose them to a head injury.
- Soft Hat
- Safety Vest – An MDOT approved safety vest shall be worn whenever working within any highway right of way or on a construction site.

- Safety Glasses – clear
- Goggles – clear or amber
- Leather Gloves
- Respirators
- Dust Mask
- Ear Protection – muff or plug
- Protective Clothing
- Foot Protection
- Personal Floatation Devices
- Fall Protection

2.1.3 Party Chief Duties

The Party Chief should ensure that all safety rules and procedures are followed and that all work is performed safely. The Party Chief must ensure the use of the safest possible method for each operation. This responsibility may not be delegated. Duties of the Party Chief include:

- Make safety the first priority in planning each survey.
- Before starting work, inspect all traffic controls for conformance to MDOT standards as stated in the *Manual on Uniform Traffic Control Devices* and continue to monitor conditions to ensure that controls are adequate for any change in conditions.
- Cease work and notify the field supervisor immediately if any field conditions become unsafe.
- Train and provide lookouts whenever necessary.
- Provide flaggers whenever necessary that have completed the flagger training course.
- Utilize protective vehicles whenever appropriate.
- Avoid assigning party members to independent tasks in high-hazard areas that isolate them from other party personnel. Try to have each member working with a buddy. This is especially important in high-hazard areas, such as along roads, and in remote woodland and swampy areas.
- Ensure that each employee possesses the required personal protective equipment and understands its proper use.
- Train new employees to safely perform required work tasks before assigning them to work.
- Ensure that tools are used and stored safely.
- Do not allow employees to work if they refuse to work safely. Refer the matter to your supervisor.
- Report all violent acts, threats of physical violence, verbal abuse, property damage, security hazards, and other inappropriate activities to the supervisor.
- Report and document all occupational injuries and illnesses.

2.1.4 Field and Office Supervisor Duties

Field and office supervisors may be first or second line supervisors. Field supervisors generally supervise more than one field party. Supervisors are responsible for conducting MDOT business in the safest possible manner consistent with Departmental policies, procedures, and work practices, including:

- Ensuring that employees who fail to comply with safety and health policies, procedures, regulations, laws, or rules are disciplined in accordance with the provisions described in the *Mississippi State Employee Handbook*.
- Ensuring that all employees receive first aid and defensive driving training, as well as any required training for hazardous tasks such as operating a chainsaw.

- Ensuring that all employees receive Safety Training for special circumstances including construction surveys on superstructures.
- Ensuring that employee safety and health issues are discussed and assessed annually at the time of issuing the "Individual Development Plan/Performance and Appraisal Summary" report and when employee probationary reports are issued.
- Scheduling staff meetings to disseminate information on accident prevention and on new safety policies and devises.
- Periodically inspecting field and office work sites to identify, document, and eliminate hazards that might cause injury or illness.
- Obtaining an approved traffic control plan, if necessary, and providing a copy to the party chief.
- Approving all surveys to be conducted without traffic controls.

Supervisors are responsible to report and document occupational injuries and illnesses, and arrange for appropriate workers' compensation benefits to employees who are injured or contract an illness arising out of their employment.

When assigning field crews to projects or sending office personal on field trips, consider:

- The experience of personnel in undertaking hazardous tasks.
- Possible health problems for specific employees (such as poison oak allergies).
- Traffic hazards (plan for any controls that are needed).
- Unusual hazards associated with the work.
- Making the employee aware of facilities that are approved for treating industrial injuries. Inform the employee that each office and survey party has a copy of the list.
- Ensuring that each party chief assigned to the field is scheduled for first aid training as soon as possible and at least once every three years thereafter according to recertification needs.
- Describing hazards that are likely to be encountered in the employee's first assignments and the protective measures to be used.
- Briefing the employee on:
  - Medical care available throughout the State.
  - Accident and injury reporting procedures and their purposes.
  - The right to refuse to perform tasks that are dangerous or hazardous.
  - Responsibilities in case of personal and/or motor vehicle accidents.

Employees who fail to comply with safety and health policies, procedures, regulations, laws, or rules, shall be subject to disciplinary action in accordance with the provisions described in the *Mississippi State Employee Handbook*.

2.1.5 Safe Driving Practices

Employees or contractor employees working for MDOT are not exempt from traffic laws. Employees operating vehicles and mobile equipment will obey all State and Local Traffic Laws and Departmental Policies, Rules and Regulations:

- The number of employees permitted to ride in a car, truck, or mobile equipment shall not exceed the seat space and seat belts as provided by the manufacturer.
- Safety seat belts installed in vehicles and mobile equipment shall be used by the operator and passengers while the vehicle or mobile equipment is in use. The operator shall not place the vehicle in motion until all occupants have properly secured their safety belts.

- It is the operator's responsibility to report all vehicle and equipment malfunctions and defective parts.
- The operator should always signal a turning movement or a lane change.

When it is necessary to stop a Department vehicle at locations where traffic does not normally stop, the employee shall give warning to following vehicles by flashing his brake lights and slowing down gradually.

Should disabled equipment, either State or privately owned, be parked on the pavement without proper protection, it is the duty of employees to protect traffic by placing fuses, reflectors or torches at the scene. In the case of privately-owned vehicles, the matter should then be referred to the nearest police agency, as soon as possible.

2.2 Construction Surveying Operations

Construction Surveys may be categorized by two different types, preliminary surveys and actual surveys during construction. Possibly the most dangerous may be the preliminary survey, as the crew will be working without the contractor's established traffic control and safety plan. They may also be working in near traffic situations without extra personnel available to perform specific safety related tasks.

During the course of any survey work, observe the following safety guidelines:

- Be extremely cautious around heavy and fast-moving equipment or vehicles, especially on highways or haul roads and around any equipment with limited driver visibility.
- Do not rely on the operator's visibility, judgment, or ability. Make eye contact with the operator before walking in front of or behind any piece of equipment.
- Use lookouts, flaggers, and temporary traffic control as conditions dictate.
- Suspend survey operations when uncontrollable hazards develop. Resume work only when safe working conditions have been restored.

2.2.1 Surveying Near Traffic

- Face Traffic – Whenever feasible, each employee must face moving traffic at all times. If it is not possible to face traffic, a lookout should be assigned to watch oncoming traffic.
- Move Deliberately – Do not make sudden movements that might confuse a motorist and cause an accident.
- Signal Cautiously – Whenever feasible, use radio communication. Carefully and deliberately use surveying hand signals so they will not startle or confuse motorists or be mistaken for a flagger's direction.
- Avoid Interrupting Traffic Flow – Minimize crossing traffic lanes and never attempt to run across traffic lanes as you might fall or trip.
- Physical Barriers – Whenever feasible, place a barrier vehicle or a shadow vehicle between moving traffic and workers.
- Distractions to Motorists – Minimize working near moving traffic, especially on high-speed roads, when the motorists' attention may be distracted by other ongoing activities such as vehicular accidents, maintenance activities, and construction operations; or distracting objects on or along the highway. Do not work along streets or highways within 2,000 feet of such activities or objects. Suspend survey activities until the hazard has cleared.

2.2.2 Lookouts

While working on foot near the traveled way, workers should normally be protected by barrier vehicles, guardrail, or other physical means. Where the absence of such physical protection exposes workers on foot to errant vehicles, lookouts shall be assigned. The lookouts only duty is to provide immediate warning to coworkers of vehicles or equipment that have become imminent hazards to their safety. The lookout shall not try in any way to direct traffic. A lookout is used only to warn of impending traffic hazards, not direct or control it.

Lookouts are always required when all of the following conditions exist:

- Work occurs on a roadway with a posted speed of 55 mph or more.
- Workers are without physical protection (barrier vehicle, k-rail, natural or man-made terrain features, etc.).

Lookouts should be considered whenever:

- Workers are working without traffic controls on streets and highways.
- Workers are working within 25 feet of the centerline of an actively-used railroad track outside of a railroad right of way.
- Where conflicting or multiple vehicular and equipment movements exist.
- In areas with restricted sight distances.

Lookouts must be in constant communication with the employee under their protection. If restricted sight distance or other factors preclude verbal communication, use a “lookout alarm device” (LAD) or radios. Whenever possible, lookouts should be stationed in the immediate vicinity of those they are protecting. In some cases, more than one lookout may be necessary. When it appears that a vehicle or some equipment has become a threat to any personnel, the lookout will immediately and repeatedly use the word “scramble,” or activate a LAD.

2.2.3 Flaggers

A flagger should be a trained person who gives motorists, pedestrians, and cyclists exact instructions, enabling them to move through temporary traffic control zones safely. Flaggers should be carefully chosen based on their ability to perform this function because they are responsible for public safety and make the greatest number of public contacts of all highway workers. Because of their importance and responsibility, flaggers should be relieved periodically to maintain alertness.

Flaggers must be used any time two-way traffic must share the same lane because of work in the other lane. Generally, flaggers should not be used along freeways.

Flaggers shall be trained in flagging procedures and use the proper equipment and warning garments outlined in the *Manual on Uniform Traffic Control Devices*. A copy of this manual should be made available to each survey party.

Flaggers shall have attended and been certified in an MDOT approved flagger certification training course.

2.2.4 Protective Vehicles

Protective vehicles can be especially important at sites, such as instrument set-ups, where surveyors might be located for an extended period of time.

There are two types of protective vehicles:

1. Barrier Vehicle – A vehicle, usually unoccupied, which is parked between the oncoming traffic and a stationary work site.
2. Shadow Vehicle – A vehicle with an attenuator which follows a survey operation moving in the direction of traffic.

Position protective vehicles so they are effective barriers to the traffic. Keep a protective vehicle close enough to employees to give actual physical protection but not so close that it is a hazard to employees.

2.2.5 Amber and Strobe Warning Lights

Amber lights should only be used to alert traffic of workers on foot or operations near the traveled way. Do not use the amber lights when driving, when parked in an established lane closure, or when no danger to the employee or motorist exists.

Misuse and overuse of warning lights seriously reduces their effectiveness. When working during the hours of darkness, use the amber lights with discretion. Do not blind or distract traffic needlessly. At times, the vehicle's emergency flashers may be more effective.

2.2.6 Temporary Traffic Control

Temporary traffic controls are used to establish a "working area-of-protection" for employees for a short duration of time.

Methods of temporary traffic control include use of:

- Portable warning/control devices
- Prescribed procedures (see below)
- Personnel such as flaggers and lookouts

Traffic movement should be disrupted as little as possible by traffic controls.

Optimum safety can be achieved most effectively through controlling the activities of surveyors rather than restricting vehicular movements. Specific procedures include:

- Do not undertake any form of temporary traffic control without consulting and following the directives of the *Manual on Uniform Traffic Control Devices*.
- Lane closures should only be undertaken with the approval of the District Traffic Manager.
- Set-up and removal of lane and shoulder closures should generally be undertaken by Maintenance using the guidelines found in the *Manual on Uniform Traffic Control Devices*.
- The protection of employees and the public shall be the primary consideration when temporary traffic control measures are used.
- All reasonable measures shall be used to avoid interference with vehicular movement. Lane and shoulder closures shall not be considered until other alternatives have been evaluated for employee protection.
- Minimize the amount of time temporary control devices are used. Do not leave traffic control devices in place when workers are not present. Traffic control devices should be removed during employee breaks.
- The party chief should inspect and monitor the traffic situation. If controls are inadequate or conditions change, surveying activities shall be halted until a safe condition is established.
- Except for special surveys or due to lack of reasonable daylight alternatives, surveys on or adjacent to roads shall be done only during full daylight hours.

- When using lane or shoulder closures, limit the total closure length to an area that can be surveyed during an uninterrupted period of work.

2.2.7 Planning

When planning a surveying project that requires temporary traffic controls, be sure to:

- Use standard traffic control layouts as shown in the *Manual on Uniform Traffic Control Devices*.
- Use surveying methods that minimize exposure to traffic hazards.
- Consider factors that will affect traffic hazards and implement temporary traffic controls to minimize the hazards. Some factors to consider are:
  - Prevailing traffic speed
  - Peak traffic hours
  - Motorists' sight distances
  - Effect of unusual survey activities on traffic
  - Pavement conditions – wet, frosty, etc.
  - Special conditions and events, such as school hours and large public gatherings
- Inform District Traffic Operations and obtain necessary approvals, if any survey activity will significantly affect the normal flow of traffic.
- Observe local district policies and procedures regarding traffic controls.
- Coordinate traffic control activities with Maintenance, Construction, and MDOT Law Enforcement, as appropriate.

2.2.8 Surveying Without Traffic Controls

Even when traffic is light, the closing of a lane or setting of other controls might be the most dangerous aspect of a survey. Under certain conditions some surveys can be undertaken safely without including the risk of establishing traffic control. Exposure and risk can be minimized without purposely affecting the flow of traffic. An example is determining elevations of edges and centerline of roadways. Short term surveying operations may be undertaken without traffic controls if all of the following conditions exist:

- Approval of the Survey Field Supervisor or Survey Manager is given.
- The traffic volume must be light. This means that surveyors can walk from the shoulder to the site on the traveled way, perform their duties, and walk back to the shoulder without interfering with traffic.
- Sight distance in each direction is at least 550 feet. When 550 feet of site distance is not available, one or more lookouts may be posted to extend visual coverage.
- Vehicles must be parked completely off the traveled way.

If all of the above conditions are met, the survey can be undertaken without traffic controls using ALL of the following methods:

- One of the survey party members shall be used as a lookout. See Section on "Lookouts."
- All surveyors shall be off the traveled way when traffic passes.
- Surveyors shall face traffic whenever possible.
- Surveyors have a planned escape route.

2.2.9 Special Operations – Night Operations

Hazards are more difficult to neutralize at night. Therefore, surveying shall not be done at night unless reasonable daylight alternatives are not satisfactory. Night surveys can disrupt traffic and arouse the curiosity of local residents. Give public notice through local news media.

Please Note: Public notices should be handled by the Outreach Division.

When planning night surveys:

- Make safety the number one priority.
- Allot extra time for all night operations.
- Make certain you have enough personnel, equipment, and supplies.
- Prepare all party members by proper briefing and issuance of adequate equipment.
- Always use the "buddy" system.
- Use reflective "Stop/Slow" paddle to guide personnel along safe roads and trails into work areas and to specific points.
- Provide radio communication for each work area.

For night surveys in traffic:

- Only consider night surveys as a last resort.
- Always seek advice and assistance from the District Offices of Traffic and Maintenance.
- Consider use of MDOT or other law enforcement agencies.
- Require all personnel to wear white coveralls and fluorescent Lime-Yellow high-visibility vests or jackets with retro-reflective material that is visible at a minimum of 1,000 feet when working anywhere in the right of way or where vehicles are likely to be moving.

2.2.10 Special Operations – Railroads

Contact Rails Division at least two weeks prior to performing a survey on a railroad's property. Rails division will contact the railroad company and send a Rails Inspector to accompany the survey crew while they are on railroad property.

Railroad operations are not to be interrupted. Observe the following guidelines when working within an operating railroad right of way:

- Always have a written permit to enter railroad right of way.
- A railroad provided or approved lookout is required.
- Whenever possible, use reflector-less instruments or remote sensing equipment, such as laser scanning, to survey the railroad tracks.
- Although you have a lookout, always be alert around railroads. Railroad equipment may not be heard, especially on noisy work sites.
- Do not crawl under stopped railroad cars or over couplings, and do not cross railroad tracks between closely-spaced cars. They might be bumped at any time.
- Do not leave protruding stakes or any holes within 10 feet of the railroad tracks.
- Do not park vehicles within 10 feet of the railroad tracks.
- Do not tape across railroad tracks.
- Do not leave instruments or other equipment unattended, on or near railroad tracks.

2.2.11 Special Operations – Water Operations

When surveying in or around bodies of water, use the following precautions:

- Wear a Coast Guard approved life jacket whenever working in a boat or in water over waist deep.
- Always perform work with a buddy.
- Never wade barefoot.
- Use a tautly stretched lifeline as a handrail when wading if stream velocity is high or the streambed is rough or slippery.

- Schedule work on beaches during low tides.
- Do not walk on floating debris.

2.3 First Aid – General Information

First aid is defined in Section 2582.1 of the *State Administrative Manual* as follows:

"The assistance provided the sick or injured before medical help is available but only with the express purpose of controlling the loss of blood, sustaining breathing, and reducing the effects of shock. Suitably trained personnel are highly recommended. Medical diagnosis, treatment, and provision of medicines or drugs (aspirin included) are not appropriate."

The following are basic requirements that must be met to ensure adequate response to a situation requiring the use of first aid.

- All survey party chiefs should be trained in first aid as soon as available and at least every three years thereafter.
- Each survey vehicle and office shall be equipped with a first aid kit.
- Each survey vehicle and office shall have a readily available copy of a current *Red Cross First Aid Manual* or equivalent.

In any emergency, always follow three emergency action steps. Following these steps can minimize the confusion at an emergency scene.

- CHECK – Check the scene.
- CALL – Call 911.
- CARE – Care for the victim.

There is also a priority list associated with injuries known as the "3 B's:

- Breathing
- Bleeding
- Bones

First aid providers should first seek to treat any problems with breathing, before attempting to deal with bleeding or a broken bone.

2.4 Work Area Hazards

Avoiding or mitigating hazards is a key to getting the job done and is also a key to getting the job done safely. Know the hazards in your job area and be prepared to deal with them.

2.4.1 Environmental Hazards – Animal and Insects

Precautions Concerning Snakes

The following precautions should be taken when working in cottonmouth, copperhead, or rattlesnake habitat:

- Always assume snakes are active.
- Do not work alone in remote snake habitat.
- Avoid stepping over logs and large rocks into unseen areas. The safest policy is to walk around such obstacles. If this is not possible, first step on top of the object, then look at the back side of the obstacle before stepping down.
- Do not jump down from overhangs onto areas where snakes might be hidden from view.

- Never climb vertical or near vertical faces using unseen handholds above your head.
- Do not attempt to capture snakes.
- When necessary to move low-lying logs, large rocks, and boards, use a pry bar, not your hands.
- When possible, maintain radio contact with isolated employees.
- Know the location of the nearest medical facility where anti-venom is available and the quickest route there.

First Aid Treatment for Snake Bites

Symptoms indicating that venom has been injected are immediate severe pain, swelling, and discoloration. Look for the symptoms and follow these procedures:

- Identify the snake, but do not attempt to kill the snake which could result in another snake bite. The fang marks, rattles, and marking and coloration of the snake should be sufficient for identification.
- Immobilize and reassure the victim. Keep the bite below the level of the heart, if possible.
- Thoroughly cleanse the wound with antiseptic.
- If possible, carry the victim to a vehicle, and then drive him to a medical facility.

Precautions Concerning Insects

Some persons are highly allergic to insect stings some even to ant bites. Symptoms of a severe allergic reaction (anaphylactic shock) are:

- Difficulty breathing
- Swollen lips, throat, and tongue
- Flushed, blotchy skin; and lowered level of responsiveness.

Employees who know they are susceptible to such reactions should inform their supervisor and co-workers of their condition and the appropriate treatments.

First Aid Treatment for suspected anaphylactic shock is as follows:

- Assist the victim with emergency medication, such as an Ana-Kit or EpiPen, if prescribed.
- Apply cold packs to minimize swelling.
- Immediately take the victim to a medical facility for treatment.
- Flying, stinging insects can also be a very serious issue for individuals that have a hyper allergenic sensitivity to their stings. Watch for signs of anaphylactic shock in persons who are stung by such insects. Take appropriate measures to get medical help at once.

Ticks

Ticks also are another source of concern while surveying and persons should document all tick bites and watch for signs of Lyme disease as well as other possible diseases associated with these parasites.

2.4.2 Environmental Hazards – Poison Oak, Poison Ivy and Other Plants

Mississippi's most allergic plant is poison ivy. Medical authorities agree that avoidance is the best prevention for an allergic reaction or Rhus Dermatitis. The old saying "leaves of three, beware of me" is still good advice. Avoidance can be difficult because Rhus-sensitive people can react, often severely, from contact with implements, clothing, and other objects that have touched the plant. Reaction can be triggered by the plant even in the winter when it has no leaves or by breathing smoke from a plant that is burning. Poison oak and ivy are not the only plants that trigger dermatitis. Persons allergic to these plants have a reaction similar to that caused by poison ivy. Precaution and treatment are the same as for poison ivy.

Precautions Concerning Plant Hazards

The following precautions should be taken when working in poison oak or ivy areas:

- Keep highly allergic employees away from poison oak or ivy and tools and clothing that have been in contact with the plant during all seasons of the year.
- Adopt a survey plan which minimizes exposure.
- Be able to recognize the poisonous plant.
- Wear long sleeves and gloves to minimize contact with the plant. Close cuffs and collars by taping. Wear State-issued, disposable, paper coveralls or work suits of white or fluorescent orange for extra protection.
- Change clothes and wash boots each day after exposure. Use strongly-alkaline laundry soap for cleaning work apparel. Dry cleaning is the one safe method for cleaning the clothing of highly sensitive persons.
- Clean contaminated tools with a commercial cleaning fluid or a very strong laundry soap. Use cleaning fluid out-of-doors. Wear neoprene or other waterproof gloves when using cleaning agents.

First Aid Treatment After Exposure to Hazardous Plants

- Immediately after exposure, wash skin thoroughly with strong soap and warm water. Rinse thoroughly with clear water after washing. Application of over the counter poison ivy treatment may help remove plant oils.
- Use medications made specifically for poison oak or ivy dermatitis.
- If the severity of the dermatitis warrants or if it persists, see a doctor.

2.4.3 Environmental Hazards – Sunstroke & Heatstroke

Sunstroke or heatstroke is an extreme medical emergency and medical aid must be obtained as soon as possible. A delay of one or two hours may mean the difference between life and death.

Symptoms of sunstroke are:

- Hot and dry skin, high temperature.
- Face red and flushed.
- Dizziness, intense headache, hard breathing, convulsions and loss of consciousness.

To treat sunstroke:

- Move to a cool, shady spot.
- Strip to underclothing.
- Lay on back, head and shoulders raised.
- Cool body with water or wet cloths.
- When conscious and able to drink, give cool drink, not ice cold. Do not give stimulants.
- Get victim to a doctor or hospital as soon as possible.

Heat exhaustion or heat prostration is not as serious as sunstroke but should be treated promptly. Symptoms of heat exhaustion are:

- Cool, moist, pale, ashen, or flushed skin.
- Headache, nausea, or dizziness.
- Weakness or exhaustion.
- Heavy sweating.

To treat heat exhaustion:

- Move to fresh, moving air.
- Loosen clothing.
- Fan the person.
- Apply cool wet towels to skin.
- If person is conscious, give small amounts of cool water to drink.
- Get to a doctor or hospital as soon as possible.

Keep in mind this simple rule for first aid in case of either sunstroke or heat exhaustion. If the patient is cold, make him/her warm; if he/she is hot, make him/her cool.

2.4.4 Environmental Hazards – Cold Weather & Hypothermia

Sufficient clothing should be worn to protect against the cold. Tight clothing that restricts the circulatory system should be avoided. If jackets or coats are worn, an orange safety vest should be worn on the outside. The jacket or coat should be of a color that will not diminish the orange vest.

Under most conditions your body maintains a healthy temperature. However, when exposed to cold temperatures or to a cool, damp environment for prolonged periods, your body's control mechanisms may fail to keep your body temperature normal. When more heat is lost than your body can generate, hypothermia can result.

Wet or damp clothing, an uncovered head, and inadequate clothing during cold, winter weather can increase your chances of hypothermia. Falling into water also increases chances. Hypothermia is defined as an internal body temperature less than 95 F. Signs and symptoms include:

- Shivering
- Slurred speech
- Abnormally slow breathing
- Cold, pale skin
- Loss of coordination
- Fatigue, lethargy or apathy

Symptoms usually develop slowly. Someone with hypothermia typically experiences gradual loss of mental acuity and physical ability, and so may be unaware of the need for emergency medical treatment.

To care for someone with hypothermia:

- Dial 911 or call for emergency medical assistance
- Move the person out of the cold
- Remove wet clothing
- Don't apply direct heat
- Don't massage limbs

2.4.5 Other Hazards – Power Lines

Regard all power lines as dangerous. Be particularly careful when using 25 foot, aluminum or fiberglass rods. Even fiberglass rods can conduct electricity under some circumstances. Notify the power company if any work is to be done around substations or Mississippi One Call (1-800-227-6477) if any digging is to be done on the survey. It’s the law!

2.4.6 Other Hazards – Radio Transmitters

Mobile radio transmissions can set off explosive charges. If you are near blasting operations, always check with the blasting supervisor before transmitting.

2.4.7 Other Hazards – Pressurized Spray Cans

Serious injuries may result from improper handling of pressurized spray cans. Observe the following rules when using spray cans:

- Do not puncture or incinerate.
- Store at temperatures lower than 120° F.
- Do not carry in vehicle passenger compartments.
- Always wear safety glasses when using spray cans.
- Do not discard any spray can in a receptacle that is normally accessible to children.
- Dispose of spray cans properly.

2.4.8 Other Hazards – Hazardous Material Spills

A hazardous material is any substance which is a physical or health hazard. Materials that are physical hazards include combustible liquids, compressed gases, explosives, etc. Materials that are health hazards are substances for which acute or chronic health effects may occur in exposed employees For specific MDOT policy on handling hazardous materials refer to the *MDOT Safety Manual*.

When an employee encounters a spill or a quantity of an unknown material or substance on or near a highway, the employee should:

- During regular working hours, call the Maintenance Region Managers, or call the MDOT Communications Center, the Mississippi Highway Patrol, or other emergency number including 9-1-1.
- Stay clear and “up wind” if possible, and avoid contact with the unidentified material.
- Provide traffic control if necessary.

If an unknown material is encountered on a job site, work should be stopped and the supervisor should be notified. The supervisor shall request the District Hazardous Materials Coordinator to determine if the job site is safe before work is continued. If you suspect that your personal safety may be in jeopardy, leave the immediate area, and telephone the appropriate authorities from another location. Do not leave the general area without notifying the proper authorities.

2.4.9 Other Hazards – Lead Contaminated Soils

Recent testing of soils along some urban freeways has revealed lead levels that are not hazardous. Even in the face of these tests, because lead enters the body through ingestion or inhalation, it is prudent to observe the following safe practices:

- Avoid working in dusty work conditions without a proper mask.
- Prevent soil ingestion by not eating, drinking, or smoking near work operations.
- Wash hands and face before eating, drinking or smoking.
- Clean hands, clothing, and shoes before entering vehicles or buildings.
- Store food and water so it will not be exposed to dust.

2.5 Hand Tool Safety

2.5.1 General Hand Tool Safety Information

- All hand tools should be kept in good repair and used only for the purpose for which designed. (e.g. axes should not be used as mauls.)
- Hand tools should be inspected regularly and defective tools removed from service. Examples of defective tools are:
  - Hammers and picks with split, cracked, or loose handles
  - Chisels with mushroomed heads and cracked points
  - Screwdrivers with split handles or bent shanks
  - Mauls with burred or mushroomed heads.
- Throwing of tools from one location or employee to another should not be permitted.
- Employees should not carry unguarded sharp-edged or pointed tools in their pockets.
- Tools should be kept clean. Grease and dirt cause slips and mashed fingers.
- Edged tools must be sharp if they are to cut cleanly with minimum effort. A sharp tool is easier to use and less likely to slip or rebound than a dull one.
- Use sheathes for blades when either carrying tools or storing them in a vehicle.
- Gang truck storage should be in a well-designed bracket, separate from the space occupied by crew members.

2.5.2 Picks

- When using a pick, be sure the area in back of you and to the sides is clear.
- Be sure that both pick points are kept sharp to prevent the tool from glancing and striking the user.
- Wear goggles.
- Obtain a secure footing and avoid swinging the pick too close to your feet.

2.5.3 Mauls and Sledge Hammers

- When using a maul or sledge hammer, be sure the area in back of you and to the sides is clear.
- Never attempt to strike an object when it is at or above shoulder height. Use a platform if necessary.
- The person who holds the stake, pin, or wedge being driven should place himself at right angles to the direction of the maul and should use a holding device to grip the driven item.
- Keep your eye on the item to be struck and exercise caution to avoid injuring the fingers of the person holding the driven item.
- In excessively cold weather, slightly warm the metal pins and maul heads before striking the pins to minimize the possibility of metal fracture and flying particles.
- Everyone should wear safety goggles.

2.5.4 Files

- Always use a file with a handle attached to it.
- Be extra careful when filing against the cutting edge of a sharp tool.
- Clean the file frequently.
- Pay attention to your work and, if interrupted, stop filing.

2.5.5 Axes, Hatchets, Machetes & Brush Hooks (Kaiser Blades)

When using an axe or hatchet, avoid rebounding it toward other workers or yourself. Sharp-edged tools, when incorrectly used, can cause accidents. Misuse of these tools can cause serious injury, and it is imperative that workers follow safe procedures.

Some general rules for brush cutting safety include:

- Always use sharp tools. Dull tools are likely to slip or rebound.
- Under no conditions should party members who are using sharp-edged tools do so within 10 feet of each other.
- Remove vines and low hanging limbs that might catch machetes, axes, or brush hooks and cause them to fly out of your hand or strike your body.
- Never use a machete, axe, or brush hook while in a tree.
- Be particularly careful when walking along a cleared survey line having protruding sharp stubs. They can cause serious injury if fallen upon.
- Maintain a distance of at least 10 feet between party members when walking through dense vegetation or woods so that rebounding branches don't cause eye injuries.

2.5.6 Brush and Tree Cutting Machete

- The machete should be used only to cut light brush.
- The end of the machete blade should not be sharpened. To reduce the possibility of injury, it can even be blunted.
- Always have a firm footing before swinging the machete.
- Strokes should be made away from the body. No cut should ever be directed downward toward the feet or toward any other part of the body.
- When not in use, the machete should be placed in a stout scabbard to reduce the chance of injury and to protect its cutting edge.

2.5.7 Axes

- Axes are for cutting trees with trunks or limbs greater than one inch in diameter.
- Make sure the head of the axe is tight on the handle.
- Proper grip of the handle is important.
    - Where working space is ample and full-force chopping is necessary, place one hand near the end of the handle and move the other toward the head as the axe is being lifted; on the down stroke, this hand should slide toward the end of the handle.
    - In crowded locations, hold the handle near its center with both hands. Strokes with this grip are easily controlled but are not too powerful.
- Keep your eyes on the spot you're aiming for.
- Do not chop frozen wood or very hard knots. They can cause the blade to rebound.
- When cutting a dead hardwood tree, be very careful because many of them are extremely hard.
- To trim limbs from a fallen tree trunk, stand to the side of the tree opposite the limb.
- Carry an axe by gripping the handle just behind the head and turning the sharp edge outward.
- The axe should be sheathed.

2.5.8 Brush Hook (Kaiser Blade)

- The Kaiser blade functions like an axe that has its cutting head reversed. It is used for rough work in brush too thick for an axe and finds its best use in thick underbrush where a low cut, requiring a long cutting edge, is needed.
- To keep the head solidly on the handle, workers should carry a tool to adjust the collar or clamp.
- Hold the Kaiser blade like you would an axe, except keep your upper hand a little more toward the cutting edge to give better balance when making a low cut.
- When cutting, try not to fight the foliage but, rather, strike at the base of the plants. Aim carefully and keep your body balanced.
- Make sure adequate clearance is maintained. The Kaiser blade can be more easily deflected than the axe because of the shape of its blade.
- Never use a Kaiser blade to cut overhead.
- Carry a Kaiser blade like axe. Keep your hand close to the head. Always point the head to the front, because the beak easily catches on vines and wires when the brush hook is carried with its head pointing backward. Never carry a Kaiser blade on your shoulder.
- Kaiser blades are difficult to store in trucks or tool houses without special provisions. Sheathes should be provided to protect surveyors and to keep the blades from being nicked.

2.6 References – Safety

Some of the material in this section was taken from the Ohio Department of Transportation, the California Department of Transportation Surveys Manual Chapter 2, Colorado Department of Transportation Survey Manual Chapter 7 and the Illinois Department of Transportation Chapter 7. Changes were made to the document in order to reflect the Mississippi Department of Transportation's authority. Anything shown herein that is in conflict with the rules and regulations of the Laws of Mississippi are not applicable and are subservient to those laws.

3.0 Project Control

For the purposes of the Mississippi Department of Transportation, control surveys are required to establish the primary and secondary control points from which all subsequent MDOT project operations are performed. Surveys of this type provide a common, consistent network of physical points that are the basis for controlling horizontal and vertical positions of roadway projects and improvements.

The horizontal datum used for all primary and secondary control on MDOT projects shall be the North American Datum of 1983 (NAD 83). All coordinates will be reported in the Mississippi State Plane Coordinate System in either the East or West zones, as appropriate. The NAD 83 control in Mississippi has been densified and re-adjusted more than once since its adoption. New projects must use the latest adjustment of the NAD 83 control values, e.g., NAD 83 (2007). Surveys to extend control on existing or continuing MDOT projects must use values consistent with the NAD 83 adjustment upon which the original project was surveyed and designed.

The vertical datum for all MDOT projects will be the North American Vertical Datum of 1988 (NAVD 88).

A minimum of three control stations will be established by GPS survey observations on all projects. These points will be referred to as the Primary Control for the project. Based on the primary control points, additional control points shall be established either by GPS observations or conventional total station traverse procedures. These points will be referred to as Secondary Control. Additional monuments may be set to furnish azimuth control for conventional total station traverse observations.

The District Control Crew should normally be responsible for establishing primary horizontal and vertical control for MDOT projects. All records and documentation of the control work performed on a project shall be kept on file by the District Surveyor. As a rule, the horizontal and vertical control surveys should be planned concurrently so that both types of surveys can use the same permanent marks whenever practicable. Additional monuments may be set to furnish azimuth control for conventional total station traverse observations.

3.1 Primary Horizontal Control

3.1.1 State Plane Coordinates

The State Plane Coordinate System (SPCS) was developed in the 1930s by the U.S. Coast and Geodetic Survey to provide a common reference system to surveyors and mappers. Before that time only latitudes and longitudes were being published for the national control monuments. Local engineers and surveyors not versed in spherical trigonometry and geodesy were unable to utilize the control for their needs. The SPCS provides an easy way to incorporate all surveys into a common datum with only knowledge of plane trigonometry. The system was designed such that the difference between the grid and geodetic distances would not exceed 1:10,000 which was considered excellent accuracy at that time. Since the state of Mississippi was too wide to be adequately accommodated in one zone, East and West zones were developed utilizing the Transverse Mercator projection. The Transverse Mercator projection was chosen because Mississippi is longer in the North-South direction than in the East-West direction. The dividing line between the two zones follows along county boundaries so that every individual county will be in a single zone. The central meridians for the two zones are located at 88º 50' latitude and 90º 20' longitude. Under the present NAD'83 datum, both meridians have the same distortion of 1:20,000 assigned but the East

meridian has an East coordinate of 300,000 meters and the West meridian has an East coordinate of 700,000 meters. The origin of both zones is now located on the 29º 30' latitude line. (See Figure 1 at the end of this section).

The grid and geodetic meridians coincide only at the two central meridians. The angle between the two is called the convergence angle and increases in value with an increase in the distance from the central meridian. With the latitude and longitude known, the convergence angle will be equal to the longitude difference times the sine of the latitude. The convergence value for a point of known position (either SPC or Latitude and Longitude) can be easily obtained by use of the CORPSCON program. (See Figure 6 at the end of this section).

A geodetic azimuth can be obtained easily at any location by applying the convergence angle at that location to the grid azimuth.

Conversion between ground horizontal distances and grid distances is accomplished by the proper application of the scale factor and the elevation factor. These individual factors can be used to compute a single factor hereafter referred to as the combined factor.

The orthometric height in Mississippi varies from near zero on the coast to less than 820 feet on Woodall Mountain near Iuka in the northeast corner of the state. The Geoid separation varies from about -85 feet along the west side of the state to nearly -95 feet on the east side of the state. Ellipsoidal heights vary from approximately -85 feet near the coast to less than +722 feet on Woodall Mountain. These parameters produce elevation factors from 1.000004 on the coast to 0.999965 in the northeast corner of the state for a total change of about 40 ppm. Within the limits of a single project, the change in the Geoid separation will usually be negligible compared to the elevation change. Even on projects where the elevation changes as much as 164 feet, the error introduced by using a single elevation factor will be less than 4 ppm.

The central meridians of both NAD83 SPCS zones in Mississippi have distortions of 1:20,000 which is equal to a scale factor of 0.999950 or 50 ppm. The scale factor will increase with the distance from the central meridians until it reaches 1.000000 at the lines of exact scale located about 39 miles from each meridian in each direction. Only a small percentage of the state is outside these lines of exact scale. Adams and Wilkerson Counties are located the farthest from the central meridians. The scale factor reaches a maximum of 1.00010 or 100 ppm along the Mississippi River in these two counties. Within the limits of a single 10 kilometer East-West project, the error introduced by using a single scale factor will be less than 5 ppm which is acceptable for most construction. The 5 ppm amounts to only 0.5 of a millimeter at a distance of 100 meters. The large scale factors near the edge of the two zones in Mississippi will reduce the combined factor but the rate of change is the greatest in these areas. Long east-west projects near the zone edges should be analyzed to determine if more than a single combined factor would be required.

Many advantages are available by using the SPC for MDOT projects. The main advantage is that all survey data is on a common coordinate system which can be re-produced in the future.

Using the SPCS will allow the collection of SPC coordinate values of the Government Land Office (GLO corners which will be located as part of MDOT surveys. Since all surveys will be on a common coordinate system, the location of the found GLO corners, even when collected on different MDOT project surveys, can be coordinated and checked against the original GLO field note data.

The SPC system provides a convenient and simple way to handle the convergence of meridians and a convenient way to exchange data between MDOT and the private sector.

Using the SPCs on MDOT Projects

All MDOT projects where Right-of-Way will be acquired shall use the SPCS NAD83 and the cover sheet of surveys and projects shall have a control note indicating that this is the system used. (See Figure 5 at the end of this section).

MDOT surveying procedure is to configure all data collectors with the project combined factor to produce grid coordinates. These grid coordinates will remain as-is throughout the preliminary survey, design, property mapping, property acquisition, and construction phases of the project. There will be no scaling to ground values during this process.

Control for MDOT SPC projects will be provided by Primary and Secondary control points established as detailed in the applicable sections of this manual.

The District Surveyor will analyze the effect of using a single combined factor for the entire project or if different factors are required for segments of the project. If the error introduced by using a single factor is acceptable, which it usually is, then this single factor can be provided to survey personnel for entry into the data collectors in preparation for gathering field data. By entering the combined factor into the data collector (MDOT state standard SMI data collectors refer to this factor as a scale value) distances gathered in the field will be converted to grid distances and SPC stored in the data file.

The difference between grid length and the horizontal length needed for stakeout will usually be less than 50 ppm. This equates to less than 5 mm in 100 meters, which will cover most stakeout situations. In cases where precise stakeout is required the setting of the combined factor in the data collector will produce an exact method for staking.

SPCs MDOT Project Examples

Analysis was done on three MDOT projects to see the effect of using State Plane Coordinates. These projects run East to West, are above average in length, and two are located far from the Central Meridian, therefore they show some worst case scenarios for errors if one grid factor or no grid factors are used during stakeout of a project.

Abbreviations Used

C.M. Central Meridian
GF Grid Factor
EF Elevation Factor
SF Scale Factor
Ft Feet
ppm Parts per million
mi Miles

	Kosciusko	Prentiss	Starkville
Project Length	1.80 mi	4.96 mi	7.66 mi
Miles from C.M.	44	31	4

Limits in feet (From USGS 7.5-minute quad sheets)	Kosciusko	Prentiss	Starkville
Min NAD27 Y	1,220,700	407,000	1,392,400

Max NAD27 Y	1,224,100	417,500	1,394,400
Change in Y	3,400	10,500	2,000
Min NAD27 X	264,500	652,000	458,750
Max NAD27 X	272,600	676,700	498,800
Change in X	8,100	24,700	40,050

Elevations	Kosciusko	Prentiss	Starkville
Low-High (Ft)	380-450	350-490	220-320
Change (Ft)	70	140	100
Geoid Height (Ft)	-88.9	-88.9	-88.9

NAD83 Scale Factors	Kosciusko	Prentiss	Starkville
West end	1.0000135	0.9999765	0.9999520
East end	1.0000092	0.9999856	0.9999500
Average	1.0000114	0.9999811	0.9999510
Error if single SF (ppm)	2.2	4.6	1.0
Error as ratio	1:450,000	1:220,000	1:1000000

NAD83 Elevation Factors	Kosciusko	Prentiss	Starkville
Low Elevation	0.9999860	0.9999874	0.9999937
High Elevation	0.9999827	0.9999808	0.9999889
Average	0.9999844	0.9999841	0.9999913
Error if single EF (ppm)	1.7	3.3	2.4
Error as ratio	1:590,000	1:300,000	1:420,000

NAD83 Grid Factors	Kosciusko	Prentiss	Starkville
Low	0.9999919	0.9999573	0.9999389
High	0.9999995	0.9999730	0.9999457
Average	0.9999957	0.9999652	0.9999423
Error if single GF (ppm)	3.8	7.9	3.4
Error as ratio	1:260,000	1:130,000	1:290,000
Error (ft/300ft)	0.001	0.002	0.001
Error if no GF(ppm)	4.3	34.8	57.7
Error as ratio	1:230,000	1:29,000	1:17,000
Error (ft/300ft)	0.001	0.010	0.020

Convergence in seconds = ME'	Kosciusko	Prentiss	Starkville
West end	-25'07.9"	+15'21.4"	-4'29.0"
East end	-24'15.7"	+17'52.3"	-0'07.9"
Change	0'52.2"	2'30.9"	4'21.1"

Please Note:

GRID DISTANCE = GROUND DISTANCE X GRID FACTOR

GROUND DISTANCE = GRID DISTANCE / GRID FACTOR
GROUND DISTANCE = GRID DISTANCE + CORRECTION PPM
GEODETIC AZIMUTH = GRID AZIMUTH + ME'

3.1.2 Point Identification

The point identification of primary control points shall be permanently marked on the monument. For rod monuments this identification should be stamped on the cover ring. For disks the identification should be applied to the disk.

Primary control points shall be identified using the route number-county code-numerical sequential value. For example, for the third marker placed in Pearl River County on I-59 the ID would be 59-55-3.

After final coordinates of primary control points are established a file shall be prepared for submittal to the Transportation Information Division for incorporation into the statewide GIS database. The point identification in this file shall be edited to include the FMS project number and construction detail code as part of the point identification. For the example noted above the GIS point identification could be 100677-301000-59-55-3

3.1.3 Method / Equipment Required

The positioning of primary horizontal control points shall be performed using only the static GPS survey method and dual frequency survey grade GPS equipment.

3.1.4 Project Planning and Execution

The general planning and performance of a primary horizontal control survey should be as follows:

- Locate the proposed project on suitable maps such as NGS quad maps, county maps, project aerial photography or other resources.
- Determine the three High Accuracy Reference Network (HARN) stations within 30 miles of the proposed project and other existing control monuments (previously established MDOT points or points of known vertical control) to be used as the fixed control ties for the GPS survey.
- Using the maps, photography or other resources determine proposed locations for the primary control points. These monuments should be placed where they will be GPS observable and should be located so the possibility of their destruction or obliteration during the time period of the project survey and construction would be minimized. The actual type of project will influence the desired location of the primary control points.
- Primary control point monuments should be established at each end of the project and additional points spaced from 0.50 to 3.00 miles apart throughout the project. Consideration should be given to making use of existing monuments (Triangulation stations, reference monuments, benchmarks, etc.) in the area to avoid the time and expense of setting new monuments. If the secondary control for the project is to be established by conventional (total station) traverse methods, additional points for azimuth control will be required and proposed locations for these azimuth points should be selected.
- Perform a field reconnaissance to determine if the selected sites for the primary control and azimuth points (if required) are suitable for GPS observation. Adjust the locations based on the field conditions.
- Install the monuments as required.
- Plan and perform the GPS observations.

- Process and adjust the field observation data to obtain final coordinates for the primary control points.

3.1.5 GPS Observations

Primary control points shall be established by static GPS observations using the following specifications:

Minimum number of control station ties required	3 B-order 1:1,000,000 HARN
Maximum distance between survey location and network control station	30 miles
Location of reference network control (relative to center of project) – Minimum number of quadrants	2
Minimum number of repeat independent baselines (Note 1)	20%
Minimum number of Independent occupations per station (Note 1)	2
Minimum length of baseline between primary control points	0.5 mile
Minimum distance between primary point and azimuth point	1,500 feet

3.1.6 Field Procedures

Max. PDOP during station occupation	5
Minimum observation time on station	2 hours
Minimum number of satellites observed simultaneously at all stations	5
Max. epoch interval for data sampling	15 seconds
Time between repeat observations (Resetting of tripod required – Note 1)	45 minutes
Fixed height tripods required	Yes
Minimum mask angle above horizon	10 degrees

Note 1: Repeat occupations of a point must be made using a different GPS receiver, antenna and operator.

3.1.7 Data Processing and Evaluation

Adjustment of GPS observations shall be performed using a commercially available least squares network adjustment software application. If the data is processed within MDOT the software shall be the current MDOT approved brand/version.

General procedures for post processing and adjustment of GPS observations have been provided below:

- Process all baselines.
- Remove trivial baselines and any which fail to fix ambiguities.
- Check the raw Loop Closures for gross errors or blunders and conformance to the specifications shown below.
- Constrain one of the reference points by setting the position of the point to match the published NGS position of Latitude, Longitude and Ellipsoid height and perform a least squares adjustment of the network.
- This minimally constrained adjustment should be evaluated to see how well the vectors fit together as a network. Compare the adjustment results for the HARN stations which were not constrained to their NGS published values. Large discrepancies between the adjustment positions and the published positions indicates the possibility of some incorrect baselines which will need to be re-measured, reprocessed, or deleted from the adjustment.

- If blunders or gross errors are detected, new observations may be required, faulty baselines removed or reprocessing of some baselines may be required.
- Add additional constraints one at a time into the network and re-compute the adjustment after each addition, checking for gross changes in position and heights within the adjustment results.
- When all constraints have been added you should evaluate the results based on the following requirements.

Relative network accuracy required	1:200,000
Fixed integer solution required for all baselines	Yes
Ephemeris	Broadcast or Precise
Loop closure analyses, maximum number of baselines per loop	10
Maximum loop length	50 miles (264,000 feet)
Maximum misclosure per loop based on loop length (ppm)(ratio to line length) (Note 1)	**1 to 5 miles** 10 ppm 1:100,000 **6 to 10 miles** 4 ppm 1:250,000 **11 to 15 miles** 2.7 ppm 1:375,000 **16 to 20 miles** 2.0 ppm 1:500,000 **21 to 30 miles** 1.3 ppm. 1:750,000 **Greater than 30 miles** 1.0 ppm 1:1,000,000
Maximum difference In baseline length for repeat baselines	0.164 feet
Maximum residual allowed in a baseline length (Note 2)	0.320 feet
Maximum relative error – Ellipses (A and B) – (Note 3)	0.050 feet

Note 1: See Leica Geo Office "Loops and Misclosures" report. There should be some judgment used in evaluation of loop misclosures. Obviously, the exact misclosure allowances encountered in the processing will involve some overlap of the values presented above. For example, the misclosure for a loop 17 miles in length could be between 2.0 ppm and 2.7 ppm.

Note 2: See Leica Geo Office Network Adjustment report "GPS Baseline Vector Residuals"

Note 3: See Leica Geo Office Network Adjustment report "Relative Error Ellipses (2-D – 39.4%).

An additional check of the results of the adjustment can be made by submitting station data to the On Line Positioning User Service (OPUS) and comparing the OPUS solution to the adjusted values. OPUS solutions may not be expected to give comparable accuracy results to a proper least squares adjustment tied to HARN field monuments, but should be used as a check against a blunder or error in the network constraints.

3.1.8 Programs Available for Aid in Converting to State Plane Coordinates

NGS and the DOD provide the CORPSCON program which allows conversion to state plane coordinates, eliminating the need for hand computations as shown in the example above. Corpscon may be obtained from:

http://crunch.tec.army.mil/software/corpscon/corpscon.html

http://www.ngs.noaa.gov/PC_PROD/pc_prod.html

Phone: (301) 713-3242

CORPSCON

Version 6.0, is a MS-Windows-based program which allows the user to convert coordinates between Geographic, State Plane, Universal Transverse Mercator (UTM) and US National Grid systems on the North American Datum of 1927 (NAD 27), the North American Datum of 1983 (NAD 83) and High Accuracy Reference Networks (HARNs). Corpscon uses the National Geodetic Survey (NGS) program Nadcon to convert between NAD 27, NAD 83 and HARNs. Corpscon, Version 6.0, performs vertical conversions to and from the National Geodetic Vertical Datum of 1929 (NGVD 29) and the North American Vertical Datum of 1988 (NAVD 88). Vertical conversions are based on the NGS program Vertcon and can be performed for the continental U.S. only. Corpscon, Version 6.0, will also calculate geoid-ellipsoid separations based on the NGS program GeoidXX (XX = 90, 93, 96, 99, and 03). Geoid-ellipsoid separations can be calculated for the Continental U.S., Alaska, Hawaii and Puerto Rico/U.S. Virgin Islands.

GEOIDS

MDOT shall incorporate the latest GEOID model in the GPS processing for project control. Use of the same GEOID model should be consistent throughout the completion of a project.

3.1.9 Availability and Recovery of Existing Control

- Check the appropriate geodetic control by consulting the NGS website. The NGS site offers several methods of searching for available NGS control.
- The data sheets for these stations contain all of the data for the station including all past recoveries. The position of the station is given in three different systems. Rectangular coordinates in meters and survey feet are given in the State Plane Coordinate System and the Universal Transverse Mercator (UTM) System. Geographic coordinates are given in latitude and longitude. (See Figures 3 and 4 at the end of this section for examples of NGS data sheets.)
- Plot all of the available control and the project limits on a USGS quad sheet or other appropriate map. Plot the project limits and the three nearest HARN stations that enclose the site on a smaller scale map.
- A two-person party should make a recon trip to recover and re-describe the control in or near the project area and select sites for new control needed.
- Have the following equipment and supplies when you attempt to recover control:
    - Hand held GPS unit
    - Metal detector/pin finder

  - Odometer
  - 100 or 50 feet tape
  - Hand level and compass
  - Probing rod
  - Shovel
  - Data sheets
  - Flagging and writing materials
- Record odometer readings and other data on the way to the station so that a new TO REACH paragraph can be prepared if the existing one is inadequate.
- Once the mark has been found, face north and prepare a field sketch of the site showing objects to be referenced and a GPS obstruction diagram of the site.
- Record the Latitude and Longitude from the handheld GPS and verify it against the published position.
- Record the property owner's name, address and phone number.
- After the stations have been recovered or if the mark could not be found report the results to NGS by the on-line recovery report portal.

3.2 Secondary Horizontal Control

In general secondary control is the system of points derived from the primary control and fills in between the primary control on a project. These points will be used for the engineering and real property acquisition work required for a project. Points established as secondary control are generally within the limits of the project and are considered expendable but recoverable. These points can be established by either GPS or conventional total station traverse methods depending on the actual field conditions. The use of the GPS static method is preferred. Secondary control traverses, level runs and GPS baselines should begin and end on different primary control points, for the purpose of forming independent loops or sections to verify the accuracy of the survey. These points may be established by either the District control crew or project office personnel. In either case they are to be done under the supervision of a Professional Surveyor.

3.2.1 Point Identification

Secondary control points shall be numbered using a prefix and a sequential number system. The first secondary control point on a project should be numbered “CP-1” with subsequent points numbered in order. (CP-1, CP-2, CP-3, etc). This system is completely different from the system for primary control so as to make the type of control point readily apparent. It is desirable that this identification mark be applied permanently to the monument used for the point, but where this is not practical as a minimum the identification of the point should be clearly labeled on a stake placed near the point, by marking paint or other suitable means.

After final coordinates of secondary control points are established a file shall be prepared for submittal to the Transportation Information Division for incorporation into the statewide GIS database. The point identification in this file shall be edited to include the FMS project number and construction detail code as part of the point identification. For example the database identification of point CP-1 on a project would be 100677-301000-CP-1.

3.2.2 Equipment Required

GPS units used to establish secondary control may be dual frequency or single frequency survey grade receivers. Total station survey instruments shall meet the following requirements:

Angle accuracy	3”
Distance accuracy	3mm + 2ppm
Dual compensator	Yes
Minimum angle display	1”

Total station instruments used for control traversing shall have been shop calibrated or checked on a calibrated baseline within one year of the start of work. If a calibrated baseline check is made it should include the tripods, tribrachs and prisms that are going to be used on the project.

3.2.3 Project Planning and Execution

The general planning and performance of a secondary horizontal control survey should be as follows:

- Determine the primary control points which are available for the project. If using conventional total station traverse methods verify that accurate azimuth points are available at the beginning and end of each planned traverse.
- Perform a field reconnaissance of the project and place and mark the secondary monuments.
- Make the necessary observations (GPS or conventional).
- Process GPS observations using commercially available processing software. For conventional traverse data use Geopak Survey to perform the adjustment.

3.2.4 GPS Observations

Minimum baseline length between adjacent secondary control points	1,500 feet
Minimum number of reference station ties required	2 MDOT Primary control
Minimum number of repeat independent baselines	100%
Minimum number of independent occupations per station	2 (100% of secondary control stations)
Max PDOP during station occupation	5
Minimum observation time on station	30 minutes
Max. epoch interval data sampling	15 seconds
Fixed height tripods required	Yes
Minimum mask angle above horizon	10 degrees

3.2.5 Data Processing and Evaluation

Adjustment of GPS observations shall be performed using a commercially available least squares network adjustment software. If the data is processed within MDOT the software shall be the current MDOT approved brand/version.

General procedures for post processing and adjustment of GPS observations have been provided below:

- Process all baselines.
- Remove trivial baselines and any which fail to fix ambiguities.
- Check raw loop closures for gross errors.
- Constrain one of the reference points by fixing the point position to the previously established values.
- Perform a network adjustment.
- Check the results of the adjustment with compliance to the specifications listed below.
- If blunders or gross errors are detected, new observations may be required or the faulty baselines removed from the adjustment.

- Constrain the second primary control point to the previously established values and perform a network adjustment.
- Evaluate the adjustment results based on the following requirements.

Secondary control points shall be established by static GPS and shall conform to the following:

Network accuracy required	1:30,000
Maximum raw loop misclosures	33 ppm
Maximum residual in a baseline between adjacent secondary control points	33 ppm

3.2.6 Total Station Traverse

Total station traverses for establishing secondary control must start on a primary control point with an accurate beginning azimuth and end on a primary control point with an accurate ending azimuth. In some cases this may consist of a loop (closed) traverse, beginning and ending on the same points.

A conventional traverse for establishing secondary control shall be made using tripods, tribrachs and prism assemblies for foresite and backsite points. No hand held prism pole traversing shall be used to establish secondary control.

3.2.7 Data Collection

Angle sets required	4 minimum
Maximum spread of sets (one setup)	5”
Maximum difference (backsite distance and foresite distance)	0.015’
Minimum distance between setup point and backsite or foresite	500’ minimum

3.2.8 Data Processing and Evaluation

Traverse observations shall be adjusted using the Compass Rule or Least Squares adjustment methods. The following specifications shall apply:

Loop or linear traverse closure (Before adjustment) 1:30,000 (Minimum)

3.3 Primary Vertical Control

Over the years several different organizations have provided fixed monumentation and data for vertical reference throughout the state. The primary organizations have been the USGS and the Corps of Engineers. Data has been referenced to NGVD 29, which have now been superseded by NAVD 88.

NAVD 88 – North American Vertical Datum of 1988 is a vertical network defined by 1 station, Father Point/Rimouski, which is an International Great Lakes Datum (IGLD) water-level station located at the mouth of the St. Lawrence River in Quebec, Canada. This 1 station mean sea level elevation was held fixed in a minimally constrained least-squares adjustment.

Orthometric Height – An orthometric height of a point on the Earth’s surface is the distance from the reference surface (geoid) to the point, measured along the plumb line. NAVD 88 utilizes orthometric height correction which processes precise gravity measurements with the leveling data. Figure 2 at the end of this section shows the relationship between ellipsoid height, orthometric height and the geoid.

3.3.1 Method / Equipment Required

Primary vertical control shall be established by using either conventional leveling devices (digital levels and bar coded rods) or by survey grade dual frequency GPS receivers. The choice of method should be made by the District Surveyor and will depend on the field conditions of the particular survey.

If conventional leveling methods are to be used to establish primary vertical control, digital levels meeting the following specification shall be used:

Accuracy (Standard deviation for 1km double run leveling)	1.0 mm (fiberglass staff) / 0.4mm (Invar staff)
BS-FS-FS-BS routine available	Yes
Data Storage	On-board memory or PCMCIA card
Download capability	RS232 port or by PCMCIA card reader

Lines may be run in only one direction if the backsite-foresite-foresite-backsite (BS-FS-FS-BS) method is used with a digital level. If this method is not used a double run (forward and back run) is required.

If conventional (digital level) methods are used it is suggested that the data recording feature of the level be used. This will prevent the normal errors of hand data recording such as transposed numbers, incorrect values, and swapped or misplaced data. Also, since the data can be downloaded to the PC software package for adjustment, the errors normally associated with manual key-in will be avoided.

Both forward and back runs of leveling will be required. (See the section "Digital Levels" below for detailed requirements for instruments required).

If orthometric heights for primary control stations are to be determined by GPS observations the methods and field procedures set forth in NOAA Technical Memorandum *NOS NGS-58 "GUIDELINES FOR ESTABLISHING GPS-DERIVED ELLIPSOID HEIGHTS (STANDARDS: 2 CM AND 5 CM)"* (Version 4.3 at the time this is written) and *"GUIDELINES FOR ESTABLISHING GPS-DERIVED ORTHOMETRIC HEIGHTS (STANDARDS: 2 CM AND 5 CM"* (draft version 1.4 as of the time this is written) shall be followed.

3.3.2 Data Processing and Evaluation

Conventional level observation data should be adjusted by a suitable adjustment program such as Topcon WinLevel or Leica LevelPac. The following specifications apply for conventional leveling:

Maximum difference between forward and back run (Section)	0.015 feet
Foresite and backsite balance difference	25 feet
Error of closure	0.035'√ D where D is the distance in miles between known elevations

3.3.3 Datum Ties

- In general, a line of levels will begin and end on published USGS or NGS benchmarks of 3rd order or better accuracy or on primary control points with NAVD 88 elevations derived from GPS observations.
- Orthometric heights will be referenced to the current NAVD and so labeled.

3.3.4 Level Rods

- All rods shall be equipped with plumbing levels.

- Rods should be stored and transported in the cases provided by the manufacturer.
- Check the rod bubble adjustment for rod verticality at least weekly. This can be done with the level's vertical crosshair if the rod is checked from the front, then turned 90 degrees and checked from the side. Rods can be checked against the wall of a vertical building or with offset measurements from a long string plumb bob inside a building. With the rod bubble held at the center, the deviation of the face and the edge of the rod from the vertical must be recorded. If the deviation from the vertical in either direction exceeds 10 millimeters on a three-meter length of the rod, the rod level must be adjusted.
- When using two-piece rods never interchange sections of the rods. Rod sections should be match marked to assure they remain as a complete unit as delivered from the manufacturer.
- Two rods shall be used when making leveling runs. This reduces the time lapse between the backsite and foresite to reduce error from tripod settlement or rebound, refraction change and relaxation of the compensator.
- Take care to protect the graduated faces of the rods. Hold the rod by the sides so as not to contact the graduations or block the reading of the rod.

3.3.5 Turning Points

- Turning pins or plates (commercially available) shall be used as turning points. In areas where turning pins or plates are not stable, a long wood stake with a double-headed nail should be driven to a firm depth.
- Avoid placing turning plates on grass or other soft surfaces. Pins should be used in such areas. Turning pins should always be set very stable in firm ground with only one high point.

3.3.6 Digital Levels

- Levels should be checked for collimation error before the beginning of a project and weekly during the project. Collimation checks shall be carried out using the manufacturers' procedures. Collimation error should not exceed 10" of arc. If it is found to exceed this value the instrument should be adjusted in accordance with the manufacturers' directions and the collimation error brought into tolerance.
- Leveling bubbles should be checked weekly and maintained in adjustment.

3.3.7 Rodmen

- The rod should rest on the turning point under its own weight, and it should be turned very carefully so as to keep the weight on the point constant.
- Replace rods on turning points very carefully if removed. It is better to keep them vertical with little motion between foresite and backsite to prevent turning pin movement.
- Be sure the rod shoe is clear of mud or dirt at each turn.
- To prevent the deterioration of the rod graduations be sure that fingers are kept on the side of the rod and not on the face where the graduations are located.
- The rodmen must be alert and adhere to proper safety procedures around traffic due to the long length and extended position of the rods.
- The backsite and foresite distances are balanced by pacing and verified by the distance reading by the instrument.
- Digital levels are usually sensitive to atmospheric conditions and will control the sight distances by refusing to read the rod if an acceptable reading cannot be obtained. The instrument operator and rodman should control the sight distances by gauging the performance of the instrument. Sight

distances should be restricted so the instrument easily obtains a reading without repeated attempts or failures to read the rod.

- Be extra careful with rod plumbing for all high rod readings, because plumbing errors increase with higher rod readings. A 10.000 feet rod reading will be in error by 0.008 feet if the top of rod is 0.400 feet out of plumb.
- Rods for a level run should me marked rod "A" and rod "B". Rods will be leapfrogged with rod A being used on all bench marks.
- An even number of setups will be used between adjacent benchmarks thus canceling any rod index error.

3.4 Secondary Vertical Control

3.4.1 Methods / Equipment Required

Vertical control will be established by conventional leveling methods using digital levels and bar coded rods or automatic levels and Philadelphia type rods.

3.4.2 Data Processing and Evaluation

The same requirements apply to secondary vertical procedures and adjustments as were specified for primary vertical control except the closure allowance shall be as follows:

Error of closure $0.050'\sqrt{D}$ where D is the distance in miles between known elevations

3.5 Location and Construction of New Monumentation

3.5.1 Primary and Secondary Control

New monuments will be established by the surveyor as needed to meet project requirements. As a rule, the horizontal and vertical control for a project should be planned concurrently so that both types of surveys can use the same permanent marks whenever practicable. When possible, monuments should be placed where they will be GPS observable.

Monuments may be designated as primary and secondary monuments. Primary monuments will be located in relatively safe locations and constructed of stable and permanent materials. Secondary control monuments will be monuments set in convenient locations for the survey work, but not necessarily in locations that will survive construction of the highway project. Secondary control monuments will be established with an emphasis on ease of use and to minimize or eliminate traversing and/or turning from control to the worksite. Primary control monuments will be established in sufficient density and locations as to facilitate quick and accurate replacement of any destroyed secondary control.

All bench marks established should possess permanency and vertical stability.

3.5.2 Monument Types

Prior to setting any monument which requires soil excavation or rod driving, the possibility of encountering underground utilities must be evaluated. A call should be made to Mississippi One Call (1-800-227-6477) so that any utilities in the area of the proposed monument can be located.

When selecting types of monuments for a project, give careful consideration to local conditions such soil stability, soil acidity, and seasonal swelling and shrinkage.

Examples of monuments to be used as Primary Control Monuments are as follows:

NGS Style Rod Monuments – Rod monuments of stainless steel such as Berntsen's Top Security monument must be installed in accordance with manufacturer's instructions. Aluminum rods may be used provided that soil conditions in the area are such that the aluminum will not excessively corrode thereby shortening the life of the monument.

Brass or Bronze Disk – Set in a drilled hole in a massive structure such as a bridge abutment.

Rebar with Cap – An aluminum cap may be used provided it is manufactured with an insert to prevent corrosion from dissimilar metals. The rebar will be of sufficient length to provide a firm and stable monument, generally four feet or more. Rebar with caps should be driven so as to place the cap 4" to 6" below ground level.

Poured in place Concrete Monuments – Poured in place concrete monuments may be used and will not be less than 8 inches in diameter and 2.5 feet deep with the bottom of the hole belled at the bottom. Loose dirt will be removed and the bottom of the hole firmly tamped prior to pouring the monument. The top of the monument will be set flush or slightly below the ground surface. A brass or bronze metal disk shall be set in the top of the monument, stamped with the monument identification. Ferrous metal such as rebar or large spikes will be cast within the monument in order to make the monument detectable with a metal detector. In lieu of ferrous metal, a permanent magnet marker such as Berntsen's DEEP1 may be imbedded within the concrete.

Pipe Monuments – Commercially produced pipe monuments consisting of a pipe with a cap, capable of being stamped, are acceptable provided they are installed in accordance with manufacturer's instructions.

Examples of monuments to be used as Secondary Control Monuments are as follows:

Rebar with Cap – Just as described for Primary Control Monument except that rebar may be 24" provided that it is firm when driven. Rebar and caps should be driven so as to place the cap 4" to 6" below ground level.

Survey Spike or Magnetized Nail – Large spikes with a center indentation and legend on the head identifying it as a survey marker may be used. Magnetized nails or PK nails may be used. These spikes and nails may be driven in asphalt and should be of sufficient length to be firmly imbedded. They should be driven through a large washer with the point identification stamped thereon.

Brass Plug – Small brass or copper markers with a knurled stem driven into a plastic anchor sleeve set in a drilled hole may be used. These monuments are set in concrete curbs, inlets, footings, islands or other stable concrete surfaces. The head of the monument should provide space for the point identification to be stamped into it.

3.6 Control Submittal

Upon the District Control crews completion of establishing initial control for a project, a 2-D design file called CONTROL.DGN should be submitted to the Project Office containing a control note as shown in Figure 6 at the end of this section. All control points established by the District Surveyor shall be shown in this drawing.

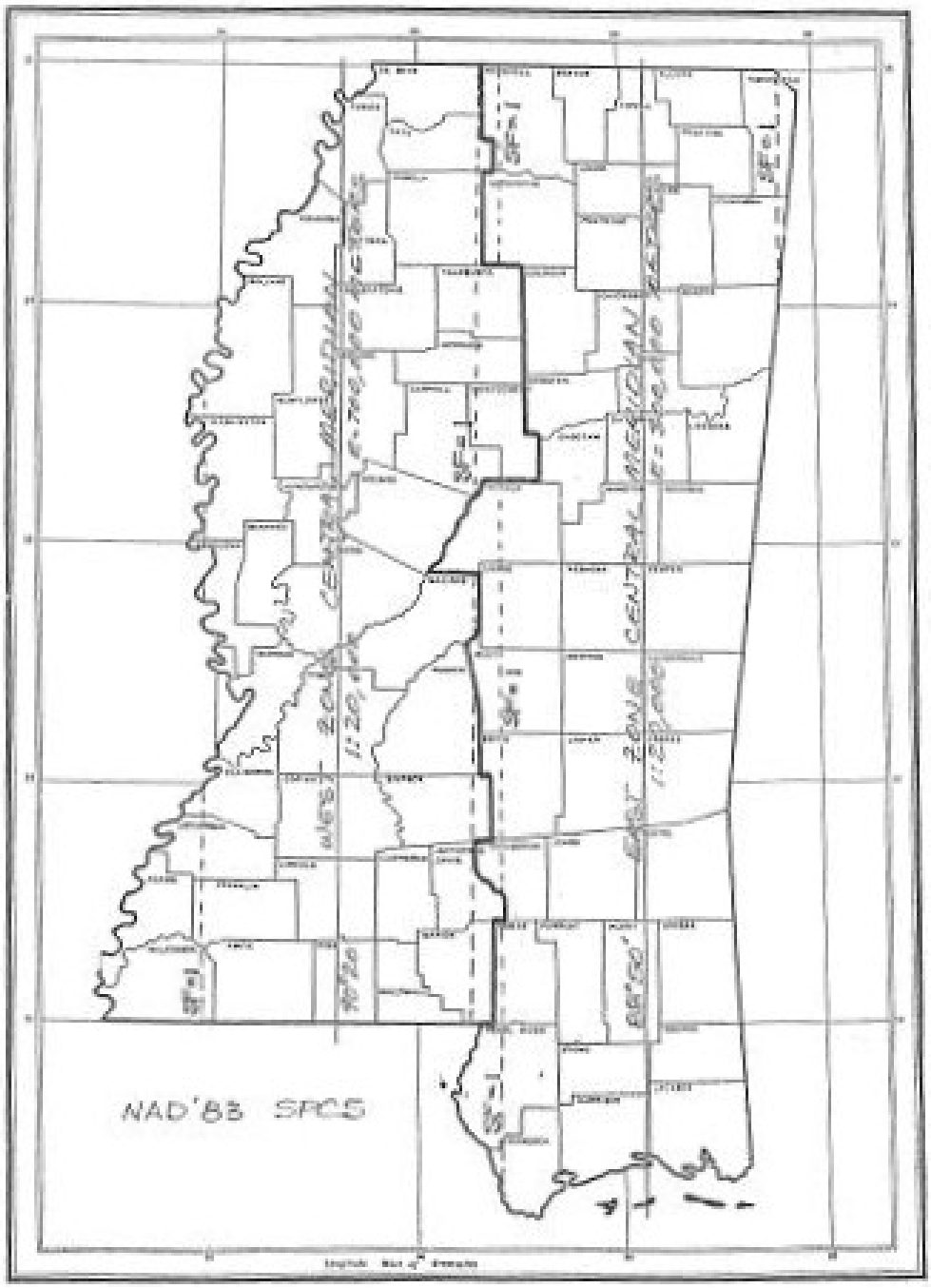
GROUND DISTANCE = GRID DISTANCE / GRID FACTOR

GROUND DISTANCE = GRID DISTANCE + PPM

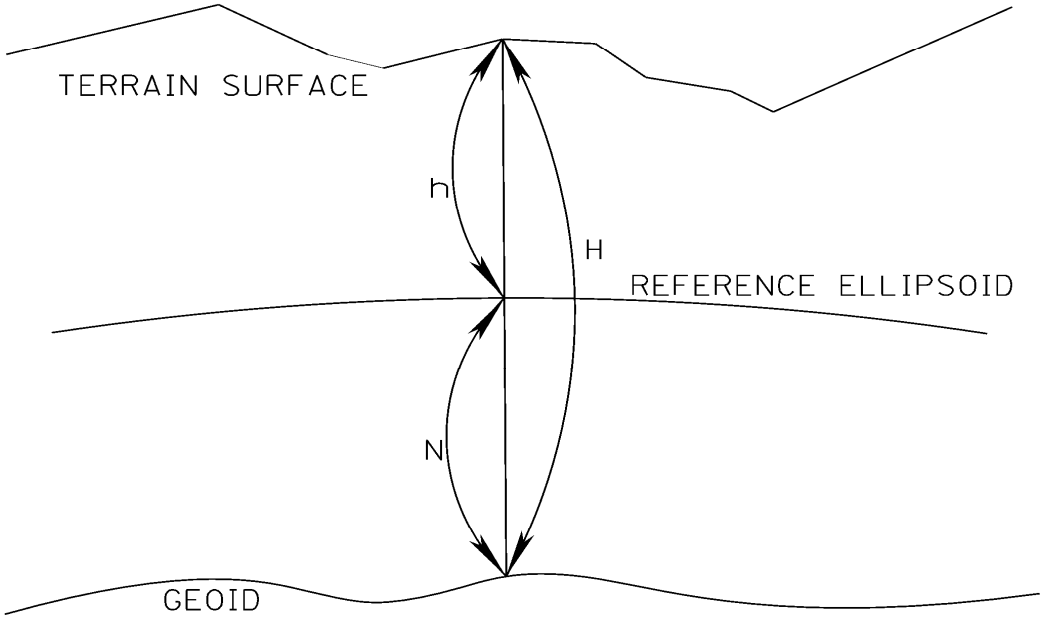
GEODETIC AZIMUTH = GRID AZIMUTH + ME'

3.7 Illustrations

3.7.1 Figure 1 – Mississippi State Plane Coordinate System Zones



3.7.2 Figure 2 – Relationship Between the Reference Ellipsoid, the Geoid and Orthometric Height



$$h = H + N$$

H ORTHOMETRIC HEIGHT OF STATION ABOVE ELLIPSOID
N GEOID SEPARATION FROM THE ELLIPSOID (CALCULATED)
h ELLIPSOIDAL HEIGHT ABOVE THE REFERENCE ELLIPSOID

3.7.3 Figure 3 – Sample NGS Data Sheet for Harn Point

The NGS Data Sheet

See file dsdata.txt for more information about the datasheet.

```
DATABASE =  ,PROGRAM = datasheet, VERSION = 7.58
1         National Geodetic Survey,    Retrieval Date = MARCH 11, 2008
 BV1824 ***********************************************************************
 BV1824  FBN          -  This is a Federal Base Network Control Station.
 BV1824  DESIGNATION  -  RUTH RESET
 BV1824  PID          -  BV1824
 BV1824  STATE/COUNTY-  MS/PERRY
 BV1824  USGS QUAD    -  RICHTON (1964)
 BV1824
 BV1824                          *CURRENT SURVEY CONTROL
 BV1824  ______________________________________________________________________
 BV1824* NAD 83(2007)-  31 21 17.85900(N)     088 56 09.37976(W)      ADJUSTED
 BV1824* NAVD 88      -         50.905  (meters)      167.01   (feet)  ADJUSTED
 BV1824  ______________________________________________________________________
 BV1824  EPOCH DATE   -         2002.00
 BV1824  X            -      101,238.567 (meters)                      COMP
 BV1824  Y            -   -5,450,697.644 (meters)                      COMP
 BV1824  Z            -    3,299,577.155 (meters)                      COMP
 BV1824  LAPLACE CORR-           -1.27  (seconds)                      DEFLEC99
 BV1824  ELLIP HEIGHT-          23.980 (meters)           (02/10/07) ADJUSTED
 BV1824  GEOID HEIGHT-         -26.91  (meters)                      GEOID03
 BV1824  DYNAMIC HT  -          50.843 (meters)      166.81  (feet)  COMP
 BV1824
 BV1824  ------- Accuracy Estimates (at 95% Confidence Level in cm) --------
 BV1824  Type     PID    Designation                        North   East  Ellip
 BV1824  ----------------------------------------------------------------------
 BV1824  NETWORK BV1824 RUTH RESET                          0.35   0.35   1.06
 BV1824  ----------------------------------------------------------------------
 BV1824  MODELED GRAV-      979,423.3    (mgal)                      NAVD 88
 BV1824
 BV1824  VERT ORDER   -  SECOND    CLASS II
 BV1824
 BV1824.The horizontal coordinates were established by GPS observations
 BV1824.and adjusted by the National Geodetic Survey in February 2007.
 BV1824
 BV1824.The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).
 BV1824.See National Readjustment for more information.
 BV1824.The horizontal coordinates are valid at the epoch date displayed above.
 BV1824.The epoch date for horizontal control is a decimal equivalence
 BV1824.of Year/Month/Day.
 BV1824
 BV1824.The orthometric height was determined by differential leveling
 BV1824.and adjusted in May 1996.
 BV1824.WARNING-GPS observations at this control monument resulted in a GPS
 BV1824.derived orthometric height which differed from the leveled height by
 BV1824.more than one decimeter (0.1 meter).
 BV1824
 BV1824.Photographs are available for this station.
 BV1824
 BV1824.The X, Y, and Z were computed from the position and the ellipsoidal ht.
 BV1824
 BV1824.The Laplace correction was computed from DEFLEC99 derived deflections.
 BV1824
```

```
BV1824.The ellipsoidal height was determined by GPS observations
BV1824.and is referenced to NAD 83.
BV1824
BV1824.The geoid height was determined by GEOID03.
BV1824
BV1824.The dynamic height is computed by dividing the NAVD 88
BV1824.geopotential number by the normal gravity value computed on the
BV1824.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
BV1824.degrees latitude (g = 980.6199 gals.).
BV1824
BV1824.The modeled gravity was interpolated from observed gravity values.
BV1824
BV1824;                      North          East      Units Scale Factor Converg.
BV1824;SPC MS E      -   205,634.716   290,237.710   MT  0.99995118   -0 03 12.2
BV1824;SPC MS E      -   674,653.23    952,221.55    sFT  0.99995118   -0 03 12.2
BV1824;UTM  16       - 3,470,560.742   315,855.488   MT  1.00001826   -1 00 27.5
BV1824
BV1824!              -  Elev Factor  x  Scale Factor =   Combined Factor
BV1824!SPC MS E      -   0.99999623  x   0.99995118  =   0.99994741
BV1824!UTM  16       -   0.99999623  x   1.00001826  =   1.00001449
BV1824
BV1824|-----------------------------------------------------------------------|
BV1824| PID    Reference Object                      Distance      Geod. Az  |
BV1824|                                                            dddmmss.s |
BV1824| CG2971 RUTH RM 3                             23.589 METERS 17709     |
BV1824| CG2970 RUTH RM 2                             31.657 METERS 17815     |
BV1824| BV1523 RICHTON MUNICIPAL TANK               APPROX. 0.7 KM 2292045.5 |
BV1824| CG2969 RUTH RM 1                             27.934 METERS 24723     |
BV1824|-----------------------------------------------------------------------|
BV1824
BV1824                          SUPERSEDED SURVEY CONTROL
BV1824
BV1824  ELLIP H (09/12/01)   23.977  (m)                        GP(       ) 3 1
BV1824  NAD 83(1993)-  31 21 17.87397(N)    088 56 09.37628(W) AD(       ) 1
BV1824  NAD 83(1993)-  31 21 17.85874(N)    088 56 09.37940(W) AD(       ) B
BV1824  ELLIP H (01/12/94)   24.039  (m)                        GP(       ) 4 1
BV1824  NAD 83(1993)-  31 21 17.87145(N)    088 56 09.37648(W) AD(       ) 2
BV1824  NAD 83(1986)-  31 21 17.87397(N)    088 56 09.37628(W) AD(       ) 2
BV1824  NAD 27       -  31 21 17.23500(N)    088 56 09.19100(W) AD(       ) 2
BV1824  NAVD 88 (04/06/99)   50.91   (m)          167.0    (f) LEVELING    3
BV1824  NGVD 29 (07/21/95)   50.88   (m)          166.9    (f) LEVELING    3
BV1824
BV1824.Superseded values are not recommended for survey control.
BV1824.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
BV1824.See file dsdata.txt to determine how the superseded data were derived.
BV1824
BV1824_U.S. NATIONAL GRID SPATIAL ADDRESS: 16RCV1585570561(NAD 83)
BV1824_MARKER: DS = TRIANGULATION STATION DISK
BV1824_SETTING: 7 = SET IN TOP OF CONCRETE MONUMENT
BV1824_SP_SET: CONCRETE POST
BV1824_STAMPING: RUTH 1921 1965
BV1824_MARK LOGO: CGS
BV1824_MAGNETIC: N = NO MAGNETIC MATERIAL
BV1824_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
BV1824+STABILITY: SURFACE MOTION
BV1824_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
BV1824+SATELLITE: SATELLITE OBSERVATIONS - June 18, 2007
BV1824
BV1824  HISTORY     - Date     Condition        Report By
BV1824  HISTORY     - 1965     MONUMENTED       CGS
```