



OPERATOR'S MANUAL AZ100 TGS Total Guidance System

Application Mode: Straight

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SERVICE • RELIABILITY • INNOVATION

Introduction

This operator's manual contains important safety, operation, and maintenance information for your Akkerman AZ100 Total Guidance System. You must read and understand this manual, the total station instruction manual and the tunneling equipment manuals before you operate and maintain the guidance system and tunneling equipment. Keep this manual with your equipment at all times. Additional copies of this manual is available from the Akkerman Aftermarket Support Department.

The contractor is responsible for the overall safety program on the job site. Use this manual as a part of the safety program.

The use of second rate parts could affect the efficient performance of the Power Pack. ALWAYS use genuine Akkerman parts.

Understand safety signal words, DANGER, WARNING, CAUTION, SAFETY INSTRUCTIONS, and NOTICE. When you see these words in this manual or on safety decals mounted on your equipment, follow the safety message to avoid personal injury and/or property damage.

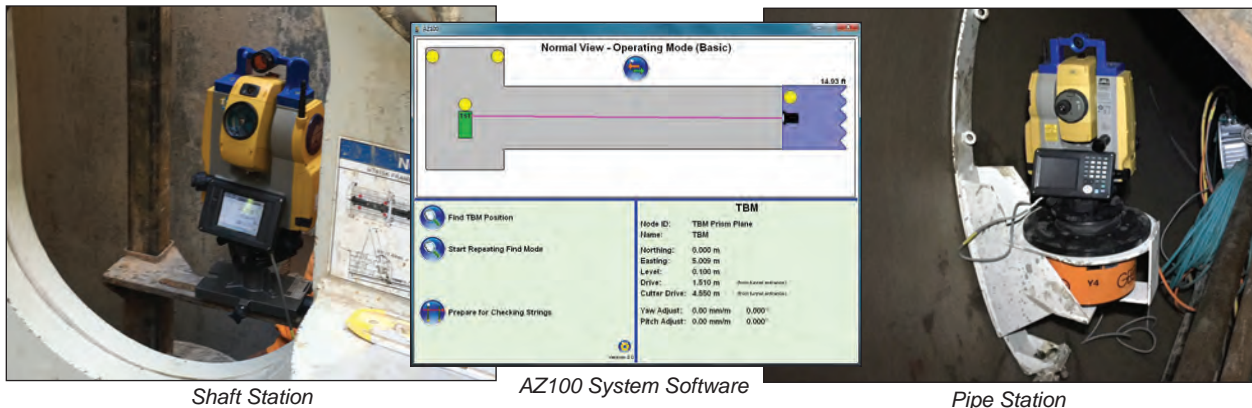
⚠ DANGER Indicates an extremely hazardous situation which, if not avoided, WILL result in death or serious injury.

⚠ WARNING Indicates a potentially hazardous situation which, if not avoided, COULD result in death or serious injury.

⚠ CAUTION Indicates a potentially hazardous situation, which, if not avoided, MAY result in minor or moderate injury. It may also be used to alert against unsafe practices.

SAFETY INSTRUCTIONS Usually consists of individual messages stating procedures or actions that must be followed for the safe operation of a product.

NOTICE Identifies potential property damage and important installation, operator, or maintenance information.



AZ100 Total Guidance System

The AZ100 Total Guidance System (TGS) is a monitoring system for extended lengths and alignments with curves. The AZ100 TGS is comprised of individual, self leveling, station units that maintain a surveyed connection throughout the alignment without the need for continuous manual surveying. The AZ100 Total Guidance System's TGS 100 target is axially mounted behind the machine's articulation cylinders at line and grade, and registers the position and angles of incidence of the red laser emitted from the guidance system. The first pipe station is added at 150-250 LF (46-76 m), and additional pipe stations are added as required along the alignment to maintain a line of sight between all stations. A vast range of distance between stations can be achieved, on average 1,000-3,500 LF (300-1,000 m) dependent upon prism size, tunnel diameter and atmospheric. The combined stations communicate a continuous electronic distance measurement for the operator to monitor exact machine X and Y positioning, real-time cutter head location and horizontal and vertical deviation with the proprietary Akkerman AZ100 software program.

If you find any errors with this supplement or know of ways to improve procedures, please let us know. Mail your suggestions to: Akkerman Inc, ATTN: Technical Publications, 58256 266th Street, Brownsdale, MN 55918.

Akkerman Inc. reserves the right to improve its product without notice or obligation.

NOTES

Contents

Safety	1	Operation	5
Be Alert For Safety Information	1-1	Operating Guidelines	5-1
Read Operator's Manual	1-1	Overview	5-2
Wear Protective Clothing	1-1	AZ100 Shaft Prism Guidelines	5-3
Avoid Laser Light Exposure	1-2	Assembling The Shaft Station (Launch Shaft)	5-4
Lockout Tagout Power Before Servicing	1-2	Finding Prism Position (Line Of Sight)	5-6
Hydraulic Oil/Fluids Under Pressure	1-2	Preparing The Shaft Station	5-9
Test Shaft & Tunnel Ventilation	1-3	Assembling The Pipe Station	5-11
Practice Safe Maintenance	1-3	Checking Total Station Tilt Offset	5-12
Using Plumb Bob	1-4	Checking Collimation	5-17
Beware Of Suspended Loads	1-4	System Setup Using AZ100 Software	5-19
Keep Personnel Away From Moving Parts	1-4	Reset Job Parameters	5-33
Unauthorized Welding	1-4	Align Tunnel To Plumb Lines	5-34
Avoid Pinch Points	1-5	Setting Reference Prism Positions	5-36
Fire Prevention	1-5	Finding TBM Position	5-38
Slippery When Wet	1-5	Start Repeating Find Mode	5-39
Keep Job Site Clean and Organized	1-6	Performing Reference Checks	5-40
No Smoking In Tunnel	1-6	Preparing For Checking Strings	5-41
Recycle Waste	1-6	Using Sleep Mode	5-42
		Daily Shut Down	5-44
		Reinstalling Total Stations In Tunnel	5-45
Safety Decals	2	Periodic Maintenance	6
Total Station	2-1	Lockout Tagout Power Before Servicing	6-1
Pipe Station	2-2	Avoid Pinch Points	6-1
		Welding	6-1
		Maintenance Charts	6-2
Terminology	3	Troubleshooting	7
TopCon® Total Station Theodolite/Shaft Station	3-1	AZ100 Software	7-1
Sokkia® Total Station Theodolite/Shaft Station	3-2	TopCon®/Sokkia® Total Station	7-2
Pipe Station	3-3	Guidance Station Kits	7-3
AZ100 Software Screens	3-4		
Power Split Box	3-5		
Ethernet Repeater Box	3-6		
Controls & Instruments	4	Specifications	8
AZ100 Software	4-1		
Shaft Station	4-1	Warranty	9
Pipe Station	4-1		
Total Station	4-2	Index	10
Reference Prisms	4-2		
Station Network Unit (SNU)	4-2		
Power Split Box	4-3		

NOTES

Safety

BE ALERT FOR SAFETY INFORMATION

When you see this safety alert symbol on your equipment or in this manual, be alert to the possibility of personal injury or property damage.

Read all safety information.

Keep safety decals clean and in good condition. Replace missing or damaged safety decals.



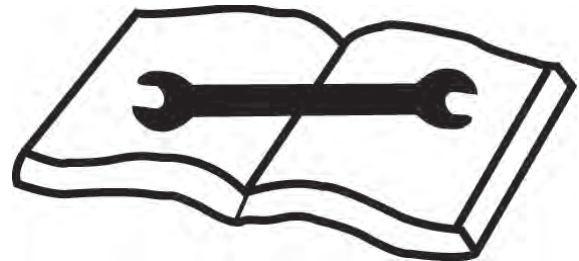
**ATTENTION!
BECOME ALERT!
YOUR SAFETY IS INVOLVED!**

READ OPERATOR'S MANUAL

⚠ WARNING Unsafe operation or maintenance can cause severe injury or death.

Read and understand the Operator's Manual before operating or servicing this equipment.

Any unauthorized modifications will void the warranty.



WEAR PROTECTIVE CLOTHING

Wear OSHA approved protective clothing, such as hard hat, gloves, safety goggles, earmuffs or ear plugs, face shield, and steel-toed boots, when operating and servicing this equipment.

Wear reasonably close fitting clothing and remove jewelry before working on or near this equipment. This will help prevent the danger of catching them in moving parts or controls.

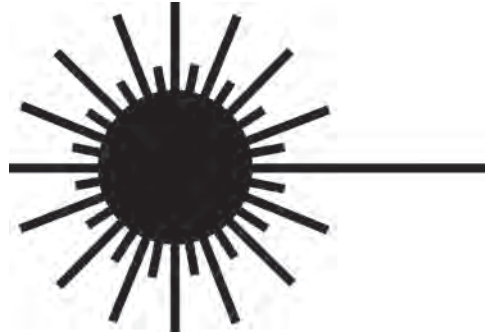


AVOID LASER LIGHT EXPOSURE

⚠ DANGER Staring into laser light will cause severe injury.

Do not stare into laser guidance system light beam. Avoid direct eye exposure.

To avoid possible exposure to radiation in excess of acceptable emission limits, all repairs to laser must be performed by the original manufacturer or an authorized service technician.



LOCKOUT TAGOUT POWER BEFORE SERVICING

⚠ DANGER Failure to lockout tagout power before servicing will cause severe personal injury or death.

LOCKOUT TAGOUT main power supply before servicing. Electrical repairs must be performed only by a certified electrician.



HYDRAULIC OIL/FLUIDS UNDER PRESSURE

⚠ WARNING Escaping oil or other fluids under pressure can penetrate your skin causing serious injury.

Release all pressure before performing maintenance or repairs. Never weld near pressurized fluid lines.

DO NOT use your hands to check for leaks. When searching for leaks, use a piece of wood or cardboard.

Contact medical help immediately if any oil or fluid is injected into your skin. A serious infection or reaction can emerge without proper medical treatment.



TEST SHAFT & TUNNEL VENTILATION

⚠ WARNING Keep shafts and tunnel well ventilated at all times.

Use an approved air analyzer to detect hazardous gases and oxygen content.

Before and during the shaft operation, test for combustible and toxic gases and oxygen deficiency.

If the levels exceed OSHA prescribed levels, leave tunnel and shaft immediately! Do not activate or deactivate any electrical or hydraulic devices, since any sparks could cause an explosion.

Once ALL personnel are out of tunnel/shaft, cut power from power source.

Gases must be removed before reentering tunnel/shaft.



PRACTICE SAFE MAINTENANCE

⚠ WARNING Unexpected equipment movement may cause serious personal injury.

LOCKOUT TAGOUT power before performing any maintenance.

Shut down equipment before making repairs, adjustments, or removing obstructions.

Only trained and qualified personnel should perform maintenance or repairs.

Keep the area around the equipment clean and dry when performing maintenance.

Do not service the machine while it is in motion.

Replace worn or damaged parts. Remove grease, oil, or debris buildup.



USING PLUMB BOB

⚠ WARNING Falling plumb bob can cause serious personal injury or death, and/or equipment damage.

NEVER hang or secure the plumb bob overhead when not in use.

ALWAYS remove the plumb bob from the string lines and place in storage container after use.



BEWARE OF SUSPENDED LOADS

⚠ WARNING Suspended loads may fall and cause severe personal injury or death.

If a hydraulic hose breaks from the boom of a crane/excavator, or the lifting support fails, the boom and/or load can fall instantly.

Do not enter area under or around a suspended load.



KEEP PERSONNEL AWAY FROM MOVING PARTS

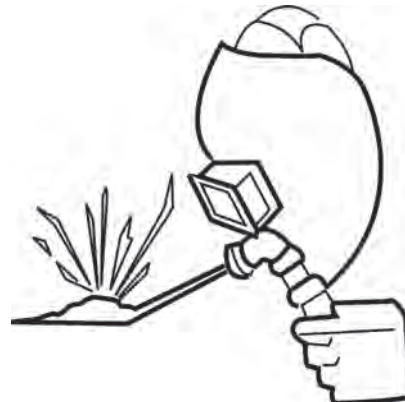
⚠ WARNING Crushing hazard.
Keep personnel away from inside of jacking frame.
Failure to do so could result in serious personal injury or death.



UNAUTHORIZED WELDING

⚠ WARNING Unauthorized welding can cause structural failure resulting in possible injury or death.

Do not weld on any structural member.
Unauthorized welding or repair will void the warranty.



AVOID PINCH POINTS

⚠ WARNING Moving parts or the mishandling of parts can cause severe personal injury.

Keep hands away from moving parts.

Watch your fingers, hands, and legs while equipment is in operation.

Handle parts carefully to avoid crushing and pinch point hazards.



FIRE PREVENTION

⚠ CAUTION Fires can cause injury or property damage.

Keep equipment clean. Remove all debris from equipment.

Have a fire extinguisher available at all times. Keep the fire extinguisher fully charged.



SLIPPERY WHEN WET

⚠ WARNING Slips and falls can cause serious personal injury.

Ensure firm footing in wet or slippery conditions.

Replace skid-resistant material if it is damaged or missing to prevent slips and falls.

Remove any buildup of grease, oil, or debris.



KEEP JOB SITE CLEAN AND ORGANIZED

⚠ WARNING Tripping can cause serious personal injury.

Be sure to keep job site clean and organized.



NO SMOKING IN TUNNEL

⚠ WARNING Smoking in tunnel could cause an explosion if combustible gases are present.

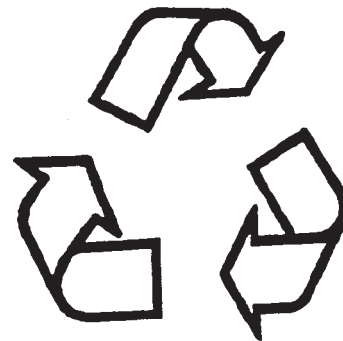
Do not smoke in tunnel.



RECYCLE WASTE

Follow local, state, federal, and international regulations when recycling or disposing of waste. Waste includes fluids/oil, filters, coolant, and batteries.

Use leakproof containers when draining fluids/oil. Do not pour waste on the ground, down a drain, or into any water source.



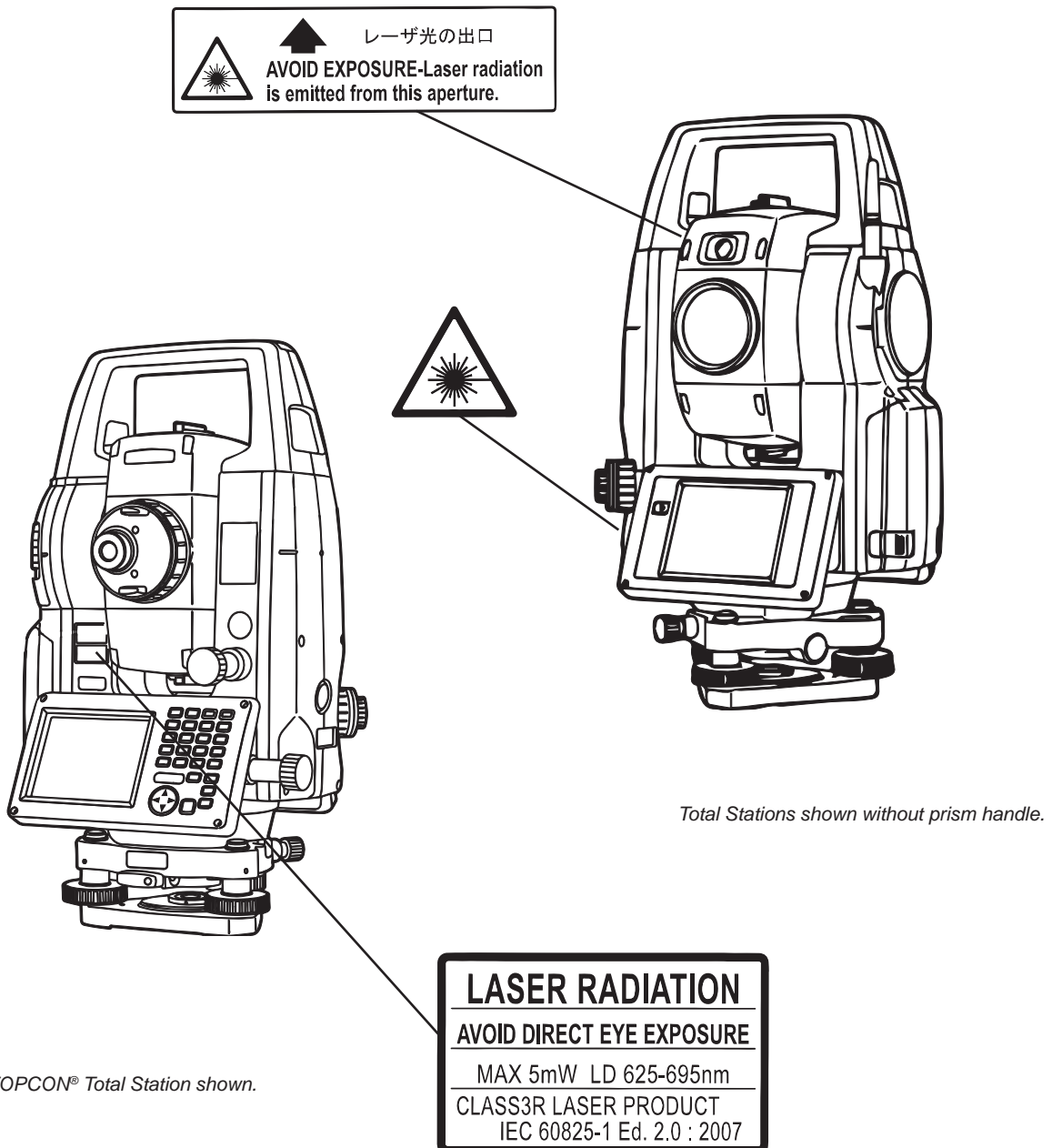
Safety Decals

Keep all safety decals clean and readable. Use soft cloth, water, and a mild soap to clean the decals if they are too dirty to read. DO NOT clean safety decals with solvent. Solvent will damage the surface of the decal. Replace safety decals immediately if they are damaged, missing, or hard to read.

Serious injury or property damage can occur if safety instructions are not followed. Contact your Akkerman Aftermarket Support representative for free replacement safety decals.

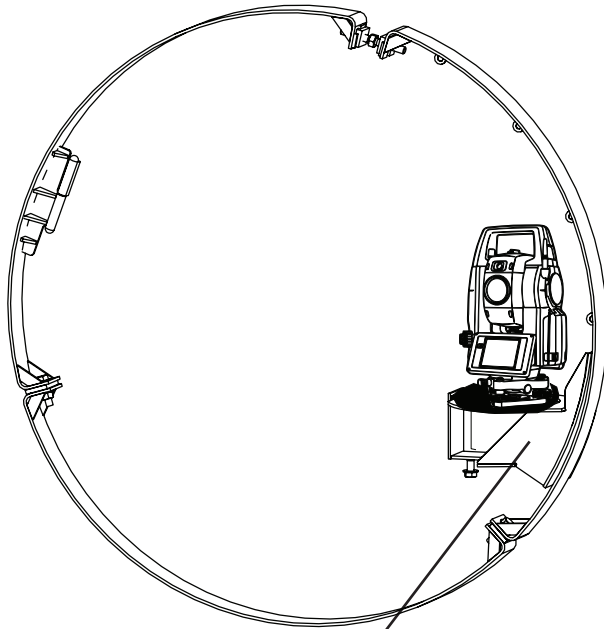
If a part is replaced that has a safety decal on it, apply a new safety decal to the replacement part. Before applying a new decal, be sure the surface is clean and dry.

TOPCON® / SOKKIA® TOTAL STATION




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PIPE STATION



Total Station shown without prism handle.

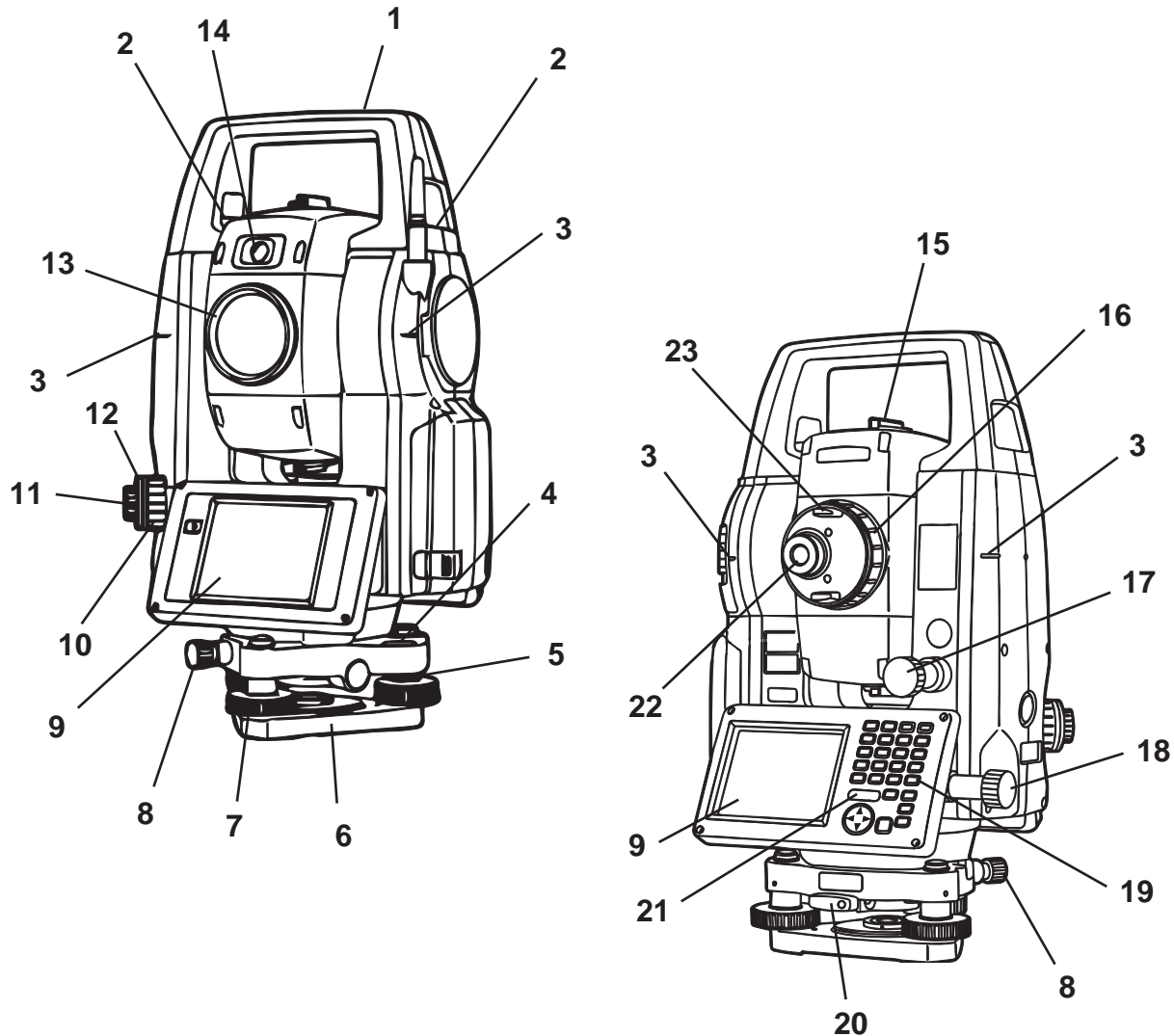
	<p>⚠ DANGER</p> <p>Staring into laser light will cause severe injury.</p> <p>Do not stare into laser guidance system light beam. Avoid direct eye exposure.</p> <p><small>1020-01 02/14</small></p>
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Terminology

TOPCON® TOTAL STATION THEODOLITE - SHAFT STATION

NOTICE

For more information, refer to your theodolite instruction manual.



Total Stations shown without prism handle.

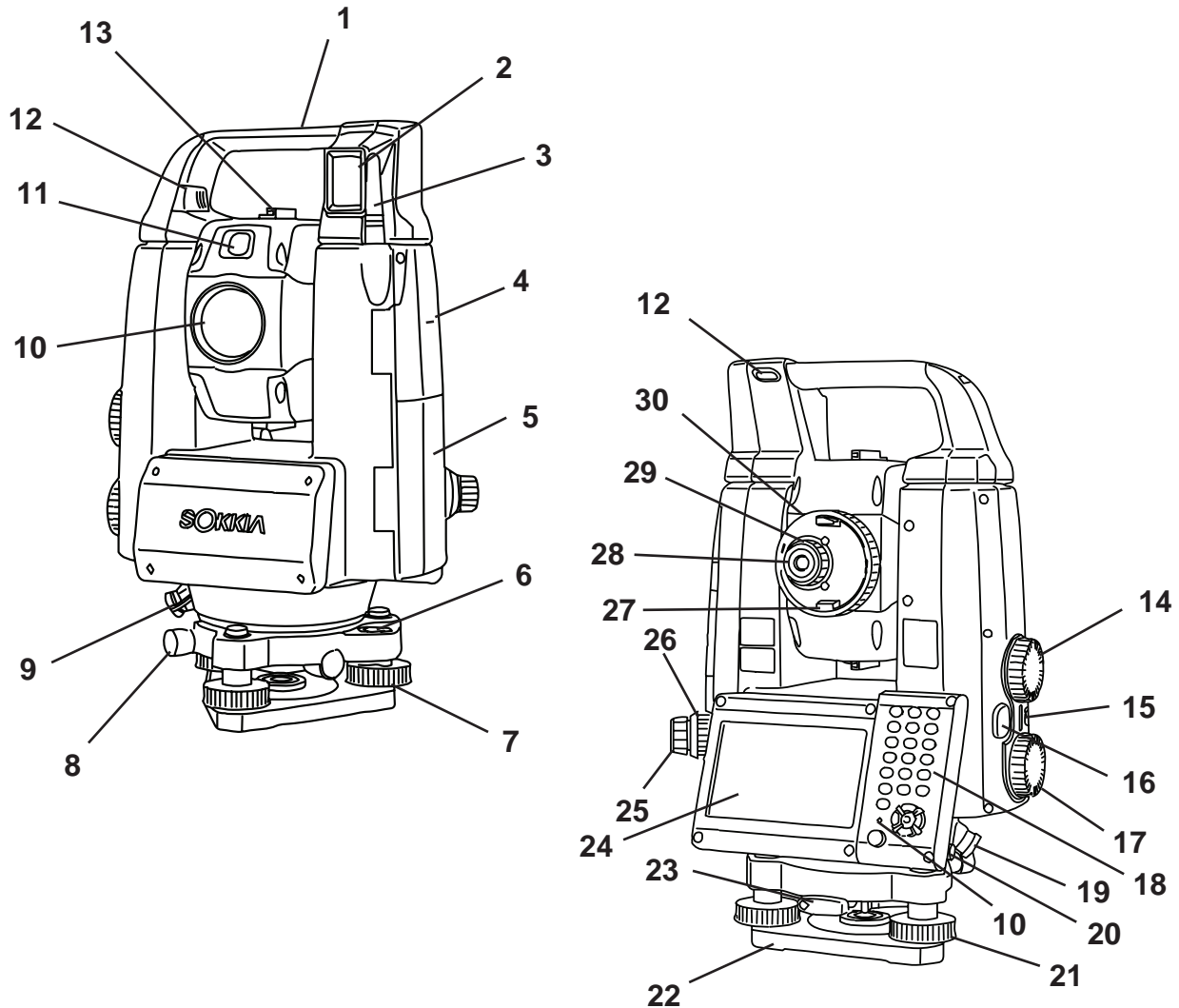
- | | | |
|------------------------------------|-----------------------------------|------------------------|
| 1. Handle (shown without prism) | 9. Display Unit | 17. Vertical Jog |
| 2. Handle Locking Screw | 10. Optical Plummet Focusing Ring | 18. Horizontal Jog |
| 3. Instrument Height Mark | 11. Optical Plummet Eyepiece | 19. Keyboard |
| 4. Circular Level | 12. Optical Plummet Reticle Cover | 20. Tribrach Clamp |
| 5. Circular Level Adjusting Screws | 13. Optical Lens | 21. Luminance Sensor |
| 6. Base Plate | 14. Guide Light | 22. Telescope Eyepiece |
| 7. Leveling Foot Screw | 15. Sighting Collimator | 23. Telescope Knob |
| 8. Tribrach Locking Screw | 16. Telescope Focusing Ring | |

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SOKKIA® TOTAL STATION THEODOLITE - SHAFT STATION

NOTICE

For more information, refer to your theodolite instruction manual.

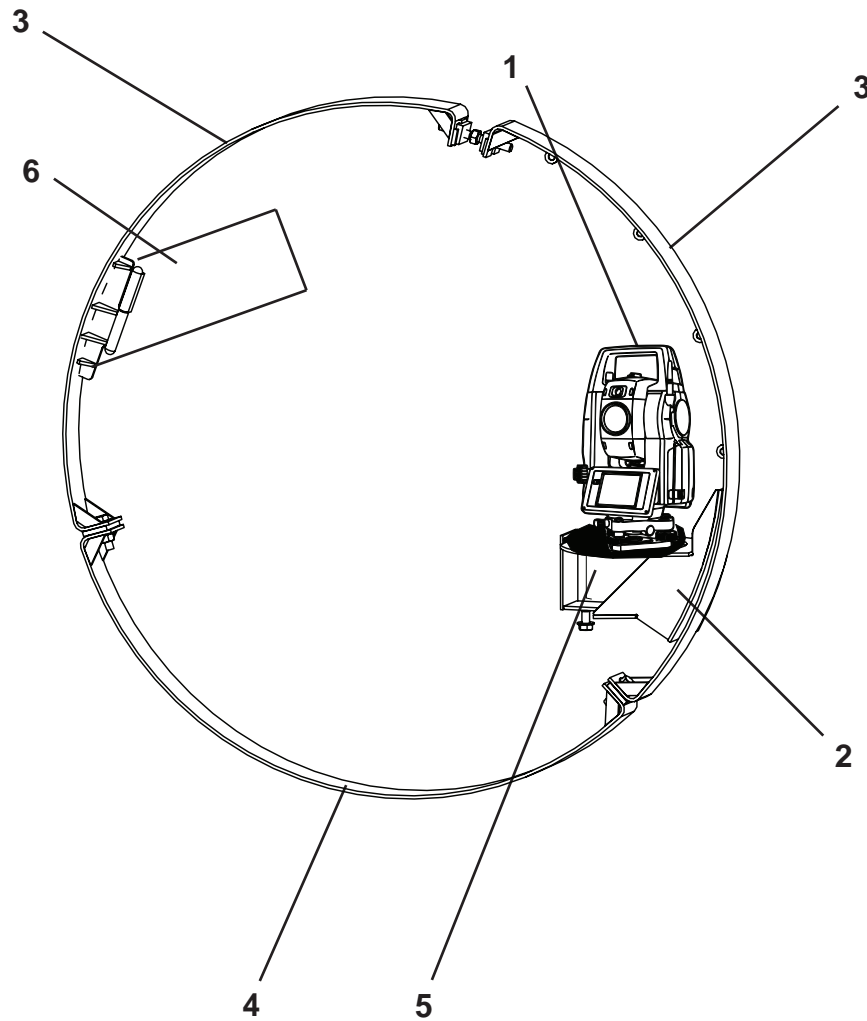


Total Stations shown without prism handle.

- | | | |
|------------------------------------|-------------------------------------|-----------------------------------|
| 1. Handle (shown without prism) | 11. Guide Light | 20. Stylus (Pen) |
| 2. Beam Detector for Remote Cont. | 12. Handle Locking Screw | 21. Leveling Foot Screw |
| 3. Wireless Antenna | 13. Sighting Collimator | 22. Base Plate |
| 4. Instrument Height Mark | 14. Vertical Jog | 23. Tribrach Clamp |
| 5. Battery Cover | 15. Power Key | 24. Display Unit |
| 6. Circular Level | 16. Trigger Key | 25. Optical Plummet Eyepiece |
| 7. Circular Level Adjusting Screws | 17. Horizontal Jog | 26. Optical Plummet Focusing Ring |
| 8. Tribrach Locking Screw | 18. Keyboard | 27. Telescope Knob |
| 9. Luminance Sensor | 19. External Power Source Connector | 28. Telescope Eyepiece |
| 10. Optical Lens | | 29. Telescope Eyepiece Screw |
| | | 30. Telescope Focusing Ring |

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PIPE STATION



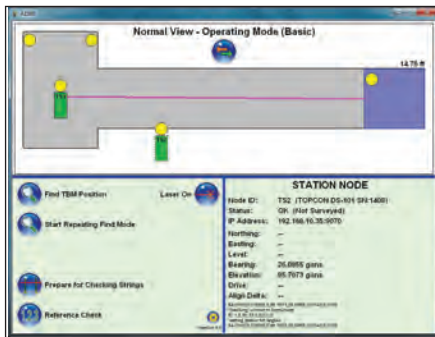
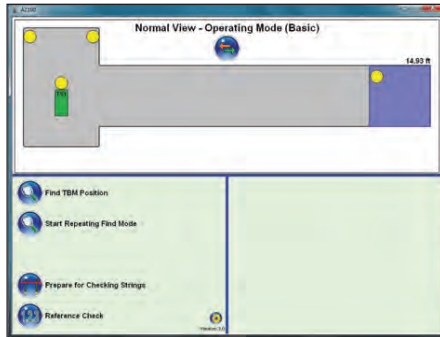
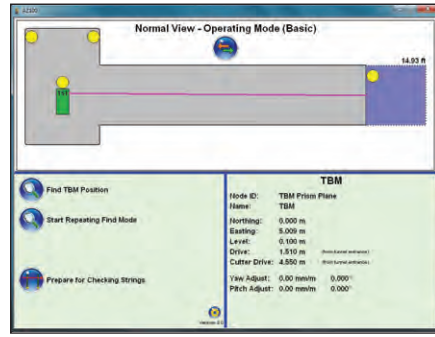
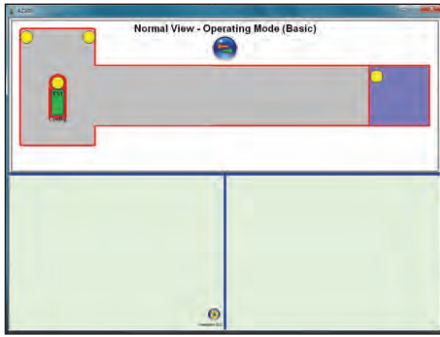
Total Station shown without prism handle.

1. TopCon Theodolite (without Prism)
2. Guidance Side Mount Assembly
3. Expandable Pipe Band
4. Pipe Band
5. Self Leveling Tribrach
6. Prism Block

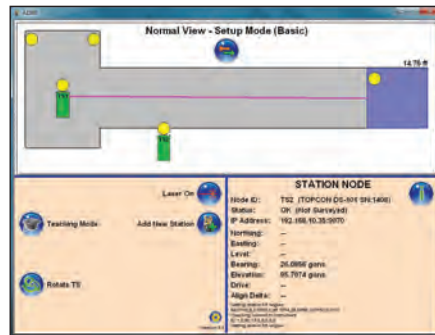
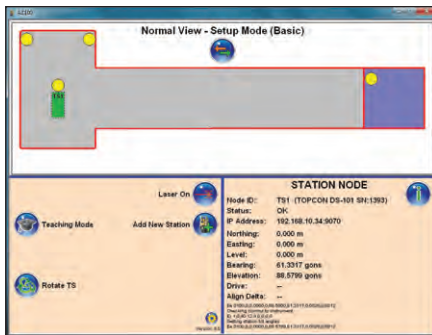
NOTE: SNU is not shown.

AZ100 SOFTWARE SCREENS

• Normal View - Operating Mode

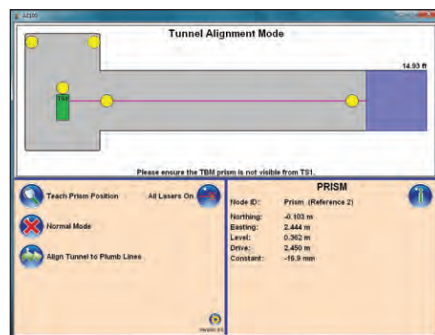
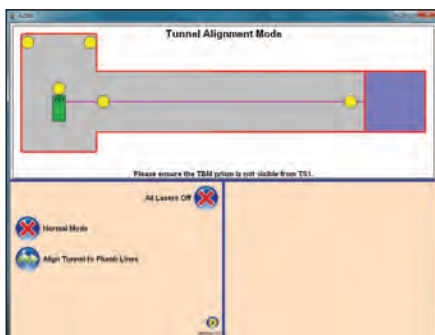


• Normal View - Setup Mode

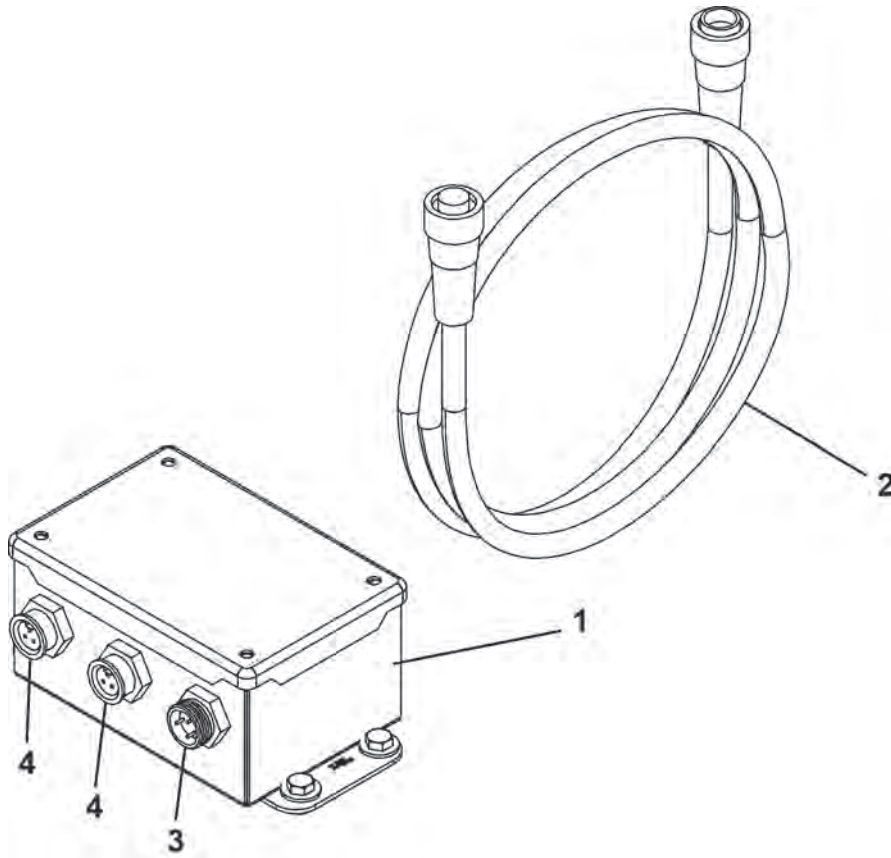


Sleep Mode

• Tunnel Alignment Mode

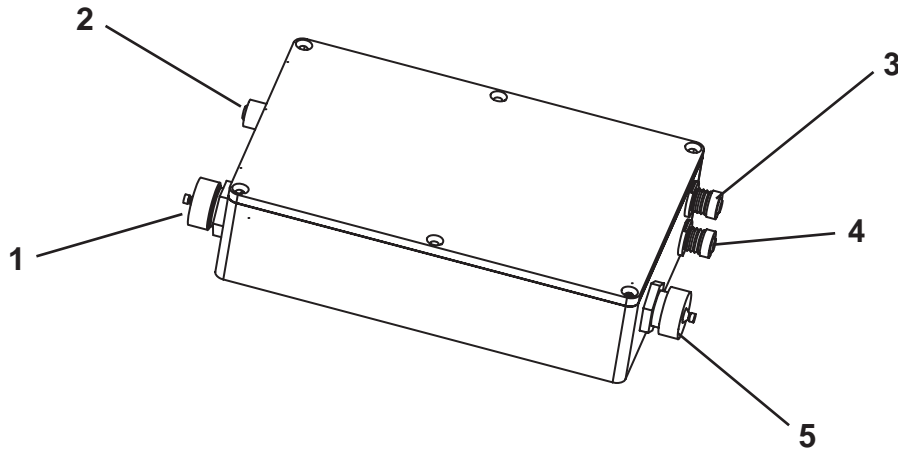


POWER SPLIT BOX



1. Power Split Box
2. 3 Pin Mini 3' Cable
3. 3 Pin Male Power Cable Connection
4. 3 Pin Female Power Cable Connection

ETHERNET REPEATER BOX



1. Power IN
2. Ethernet IN
3. Ethernet OUT
4. Spare Ethernet OUT
5. Power OUT

The recommended maximum length of Ethernet cabling is 300 ft (91 m). At 300 ft of the ethernet cabling, either a SNU or an ethernet repeater box will have to be installed.

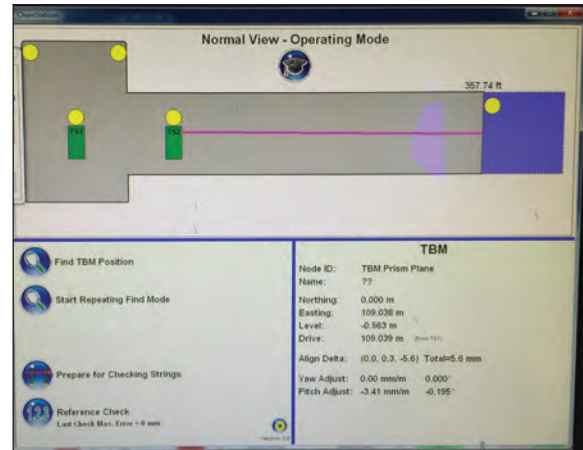
Typically a SNU is installed per pipe station but can be used independently as an ethernet repeater if there is an extra one on the job site.

Controls & Instruments

AZ100 SOFTWARE

The AZ100 Total Guidance System (TGS) software is used in conjunction with the shaft and pipe station units, to monitor the exact machine positioning and allows system monitoring for extended lengths and alignments with curves. A surveyed connection is maintained throughout the alignment without the need for continuous manual surveying.

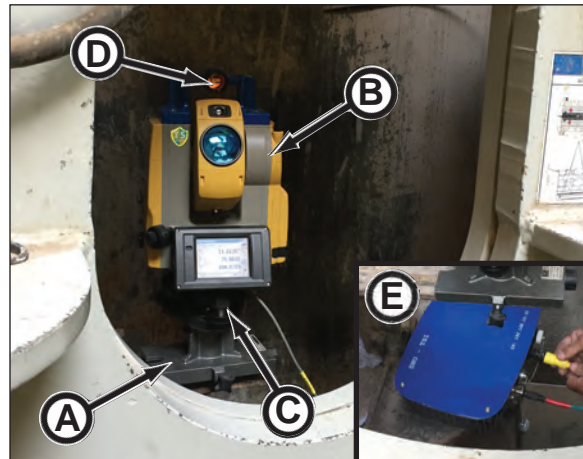
This system can be used for extended and curved tunneling in pipe jacking and microtunneling applications regardless of equipment manufacturer.



SHAFT STATION

The shaft station is located behind the jacking frame in the launch shaft and consists of the sliding guide (A), total station (B), tribrach (C), prism (D) and Station Network Unit (SNU) (E).

The shaft station theodolite provides the means of precisely measuring the machine position.



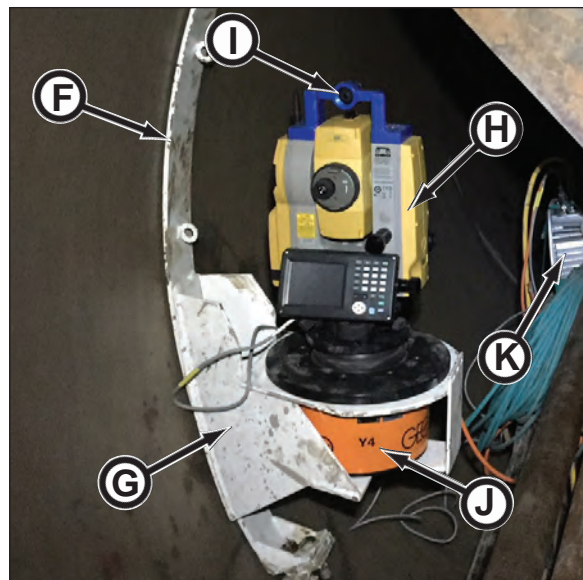
PIPE STATION

The pipe station consists of the pipe band (F), side mount (G), total station (H), prism (I), self leveling tribrach (J) and a Station Network Unit (SNU) (K).

The pipe station is essentially the same as the shaft station except for the mounting in the pipe and a self leveling tribrach.

The first pipe station is installed at a maximum 150 - 250 linear feet (46 - 76 m). Additional pipe stations are added as required along the curved tunnel alignment to maintain a line of sight between all stations.

As is the case with the shaft station total station, the pipe station total station provides the means of precisely measuring the machine position.



(continued on next page)

TOTAL STATION

A Total Station is an optical surveying instrument that integrates an electronic theodolite with an electronic distance meter.

It will monitor the line and grade of the tunnel with precise accuracy.

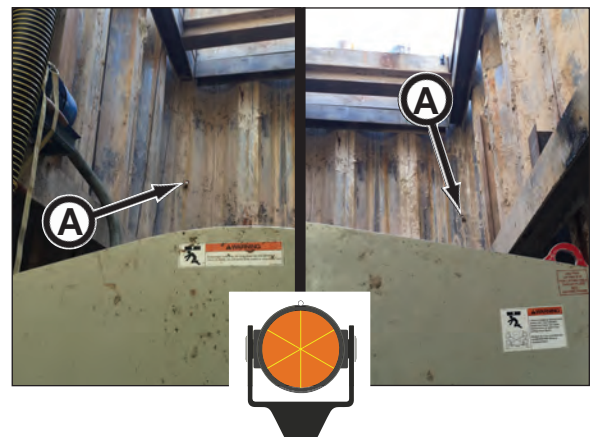


REFERENCE PRISMS

With a straight tunnel, there are two reference prisms (A).

Once surveyed, the reference prisms are one of the critical elements to maintain an accurate tunnel.

The total station will perform a reference check based on the location of the prisms for errors. If errors occur, it may indicate a prism or prisms are not in the original position or possibly the shaft station was bumped.



STATION NETWORK UNIT (SNU)

The Station Network (Node) Unit (SNU) is an interface box which receives the 110 AC and the incoming ethernet link cable. It then powers the total station and sends the communication commands to the total station. This also provides power to the self leveling tribrach in the pipe station.

If the tunnel will require two or more pipe stations, the SNU is equipped with an additional power connection and an extra ethernet connection to daisy-chain from the pipe station ahead.



Shaft Station SNU Mounting

POWER SPLIT BOX

The power split box adds additional power connections for the guidance system on control containers and MTBMs that are not equipped with extra 3 pin 120V power connections.



NOTES

Operation

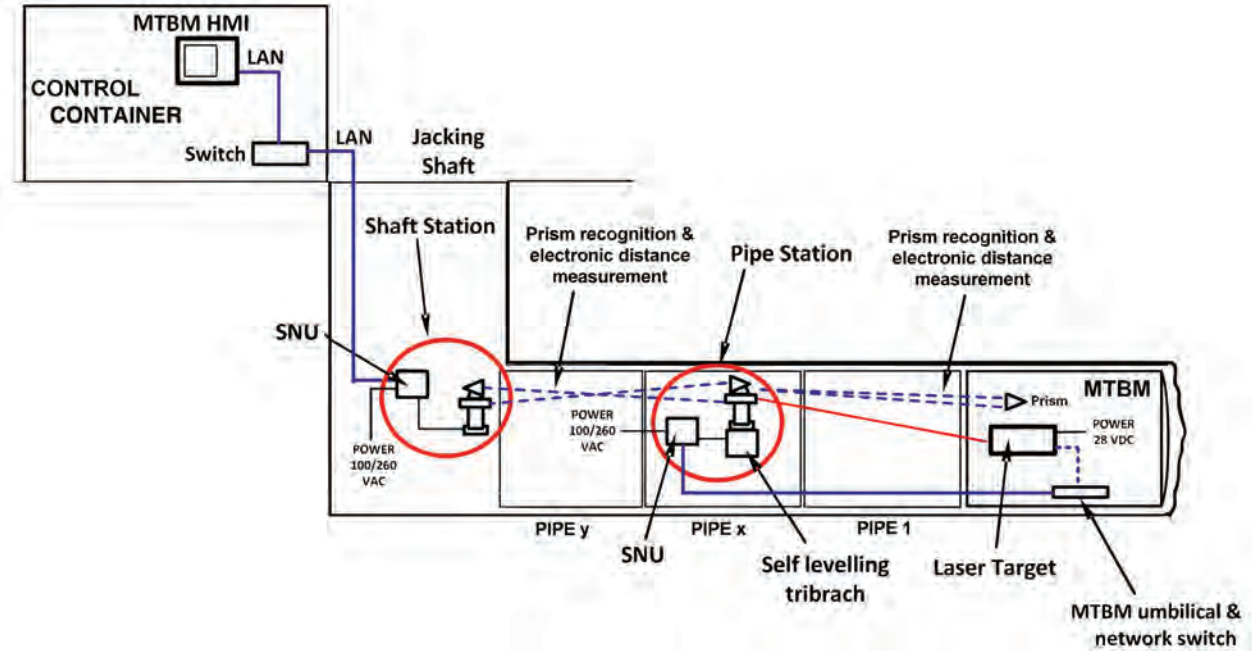
OPERATING GUIDELINES

⚠ WARNING

Do not operate this equipment until you read, study, and understand this manual, the total station instruction manual, and your tunneling equipment instruction manuals before you operate and maintain this equipment. Failure to do so, could result in severe personal injury or death.

1. Before operating, read and understand the Safety and Operation sections.
2. Do not operate this equipment while under the influence of alcohol, drugs, or medication.
3. Follow all Federal, State, and Local safety regulations and procedures.
4. Be sure OSHA prescribed safety personal protective equipment is being worn by all personnel.
5. Be sure the area is safe for operation. Keep work site clean and organized.
6. NEVER operate equipment if it has been engulfed with water. Contact your Akkerman Aftermarket Support representative for proper procedures on how to restore equipment for operation.
7. Have a fully charged fire extinguisher on the job site at all times.
8. Before operating, repair all equipment problems.
9. Be sure the excavated launch and reception pits or shafts are properly shored or braced to prevent slides or cave-ins.
10. Test air monitoring and ventilation detectors for proper operation. Never enter a tunnel without gas detectors.
11. A fully trained and qualified signal person must direct the excavator or crane operator when lifting and lowering equipment into the launch or reception pits.
12. Never walk or work under any part of the excavator or crane and suspended loads.
13. Remove plumb bobs from string lines and place in storage container after use. Never hang or secure plumb bobs over shaft. Doing so may cause severe injury or death, or equipment damage from a falling plumb bob.
14. When securing the total station in the carrying case, be sure all latches, including the side latches are closed. Do not place the instrument in a case with a damaged latch or handle. Failure to do so will result in the instrument falling out while being carried, causing damage to the instrument and possible injury.
15. Never look at the sun through the telescope. Loss of eyesight could result and potential instrument damage can occur.
16. Do not look at reflected sunlight from a prism through the telescope. Loss of eyesight could result.
17. Tighten the adjustment tribrach clamp securely. Failure to properly secure the clamp could result in the tribrach falling off while being carried.
18. When securing the instrument to the mount, tighten the centering screw completely. Failure to tighten the screw properly could result in the instrument falling off the mount causing injury or damage.
19. Check total station level often and check line and grade alignment on target monitor often to avoid misalignment.
20. Lockout tagout electrical power at the source (generator) before servicing electrical components.
21. If this manual is lost, contact your Akkerman Aftermarket Support representative for a new manual or download this manual from the Akkerman web site at www.akkerman.com.
22. Do not make any modifications to any Akkerman products. Doing so could cause structural failure and will void the warranty.

OVERVIEW



An accurate tunneling guidance system is critical for long distance and curved installation success and operator's must rely on the precision of the monitoring system. The AZ100 Total Guidance System was developed for tunneling, pipe jacking and microtunneling applications.

The AZ100 Total Guidance System includes individual, self leveling total station units, prisms and software to monitor the tunnel alignment without the need for continuous manual surveying.

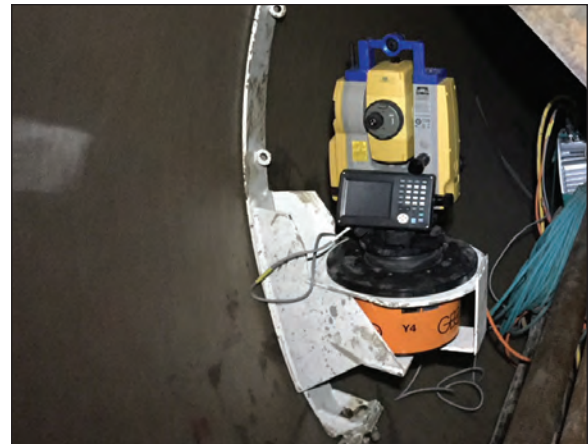
With the TGS 100 target axially mounted behind the machine's articulation cylinders at line and grade, the shaft station is installed behind the jacking frame, independent of jacking forces, to communicate the position and angles of incidence of the red laser emitted from the total station to the target.

The first pipe station is installed at approximately 150 - 250 linear feet (46-76 m) with a self leveling tribrach. Additional pipe stations are added as required along the alignment to maintain a line of sight between all stations.

The AZ100 software and the combined stations in the tunnel communicate a continuous electronic distance measurement for the operator to monitor exact machine X and Y positioning, real time cutter head location and horizontal and vertical deviation.



Shaft Station In Launch Shaft

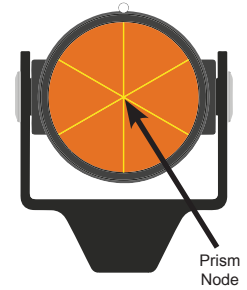


Pipe Station In Tunnel

AZ100 SHAFT PRISM GUIDELINES

It is critical the shaft reference prisms are installed properly. Failure to do so will result in tunnel data error.

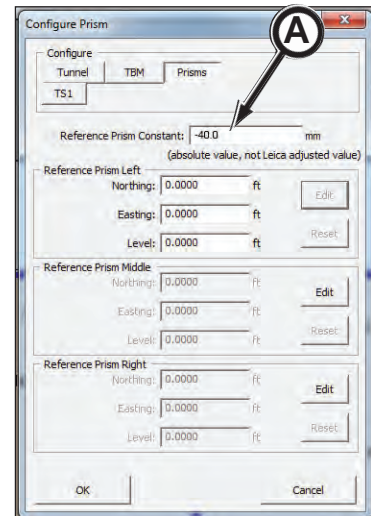
In general, the prisms must be in line of sight of the shaft total station (theodolite), as far from shaft station as possible and the prisms as far away as possible from each other. Prisms must be oriented so the total station can line up with the laser beam squarely (perpendicular) to prism. A straight (Basic) tunnel requires two reference prisms. A curve (Global) tunnel requires three reference prisms.



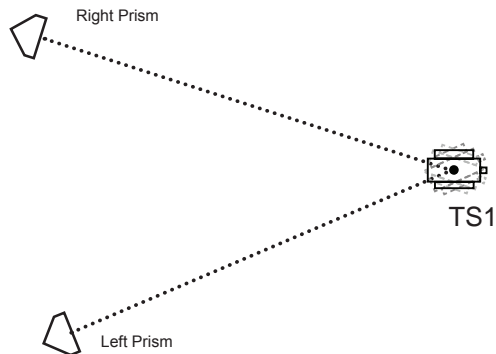
Specifically for a straight tunnel:

1. The prism mount must be sturdy and attached to a non-thrust surface. The mounted prism **CANNOT** move.
2. **IMPORTANT:** The prism node **MUST** be visible from TS1 (shaft station).
3. Prism **CANNOT** be moved after being surveyed. If a prism is moved, a new survey will be required along with AZ100 setup.
4. Enter the proper value for the Reference Prism Constant (A) when configuring the prism in the System Setup Using AZ100 Software Program in this section. An improper prism constant value will cause errors.

IMPORTANT: Shaft prisms purchased from Akkerman are -40 prism constants. If using a different style prism, you must verify and communicate the prism constant (the value is provided by the prism manufacturer) to Akkerman.



5. The two reference prisms **MUST** be as far apart as possible. Doing so prevents the chance of the shaft station from incorrectly configuring the wrong prism.
6. All prisms **MUST** be facing TS1 (shaft station).



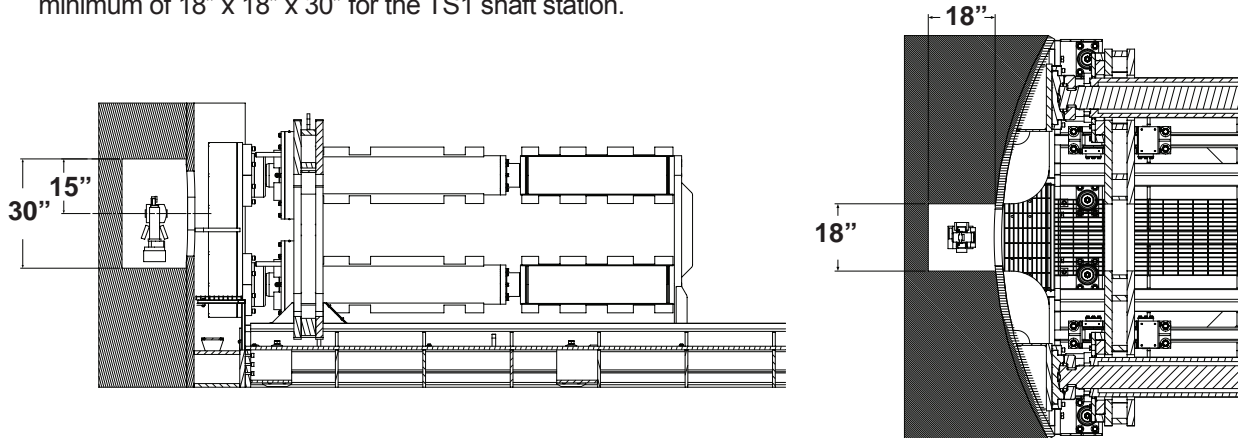
Prism Setup As Viewed From Overhead

ASSEMBLING THE SHAFT STATION (LAUNCH SHAFT)

NOTICE

The guidance system must be installed independent of the thrust wall, jacking frame and thrust forces.

1. When building the thrust wall, allow an opening a minimum of 18" x 18" x 30" for the TS1 shaft station.



Minimum Opening In Thrust Wall For Shaft Station

2. Construct a mount (A) for the shaft station. It must be mounted behind the jacking frame and isolated from any thrust forces. The mount must not be attached to any part in the shaft that may move when forces are applied.

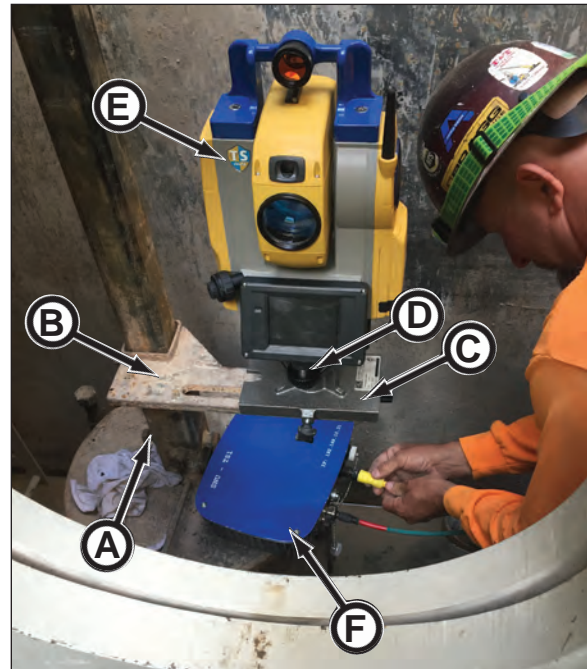
In addition, the arm mount (B) for the total station should be centered on the centerline of the pipeline as indicated by the surveying marks.

3. Level arm mount front to back and side to side.
4. Center and secure sliding guide (C) to arm mount with 5/8" bolt.
5. Secure tribrach (D) to sliding guide with locking knob. Hand tighten only.
6. Clamp total station (E) to tribrach. The total station must be able to freely rotate in all directions. Also, be sure the total station is protected on all sides including area above theodolite to prevent damage from falling objects.

The total station must be oriented as close to the tunnel axis as possible to allow it to easily find the alignment prism when requested during software setup.

7. Install SNU (F). The SNU must be installed within 10 ft (3 m) of the total station.
8. Connect power (yellow) and ethernet (green) cables from control container to SNU.

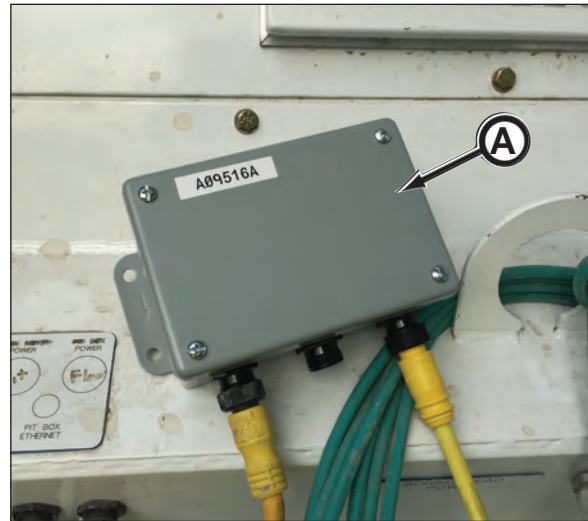
(continued on next page)



NOTICE

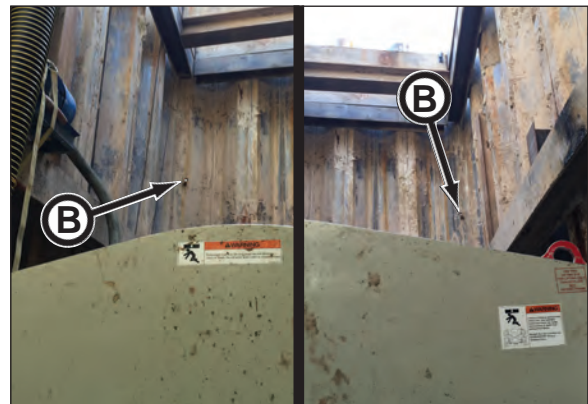
A power split box (A) must be installed on control containers and MTBMs that are not equipped with extra 3 pin 120V power connections for the guidance system.

9. Connect communication/power (gray) cable from SNU to the total station.



10. Install two prisms (B) in the launch shaft to a non-thrust surface (refer to AZ100 Shaft Prism Guidelines in this section). In addition, the prisms must be in line of sight of theodolite, as far from shaft station as possible and the prisms as far away as possible from each other. Prisms must be oriented so the total station can line up with the laser beam squarely (perpendicular) to prism.

11. Proceed to Preparing The Shaft Station in this section.



FINDING PRISM POSITION (LINE OF SIGHT)

After mounting the reference prisms in the launch shaft, it is important to check that the shaft station is able to clearly view the prisms.

The prisms must be in line of sight of the shaft total station (theodolite), as far from shaft station as possible and the prisms as far away as possible from each other. Prisms must be oriented so the total station can line up with the laser beam squarely (perpendicular) to prism.

NOTICE

Though this procedure is shown with the Sokkia® Total Station, using the TopCon® Total Station may look different but procedurally is the same.

NOTICE

This procedure MUST be performed independently of the AZ100 software. This check procedure is only confirming that the shaft station is able to view the prisms **BEFORE** the AZ100 system setup.

1. Press red button (A) to turn on the shaft station.



2. Once the shaft station boots up, press the light bulb button (B) to brighten screen.



3. Level total station (refer to Preparing The Shaft Station in this section or your refer to your Total Station Operator's Manual).

NOTICE

Depending upon the mounting location of the total station, you may need to rotate the total station base to access the keyboard and display buttons.

4. Turn laser light on by pressing button (C). When laser is on, the button will illuminate in red.



5. Press ESC button (D) to display the Basic Operation - SHV screen.



(continued on next page)

6. Press right arrow (A) to scroll to next screen.
7. Manually point the total station laser close to prism.

NOTICE Using red laser glasses may enhance the laser beam visibility.



8. Press SRCH (B). The total station will begin searching for the prism.



9. Once prism is found, the total station will stop searching.
10. Turn laser on (C) to confirm the total station is pointed at prism.



If prism is not found, the Target not found !! window will appear on the display.



(continued on next page)

Operation - Finding Prism Position (Line Of Sight)

11. Double check that the prism is found.

IMPORTANT: DO NOT move the total station.

a. Press left arrow (A).



b. Press MEAS button (B).



c. After pressing MEAS, the total station will measure the distance from the total station to the prism. The distance (C) is shown on the display.

d. Confirm that the displayed measurement is somewhat close to your estimate.



12. Repeat steps 6 through 11 for other prism.

PREPARING THE SHAFT STATION

NOTICE

The total station should initially be leveled using the bubble level on the tribrach and then use the electronic bubble display for a fine adjustment. When using the touch screen with either a finger or stylus, be careful to avoid disturbing the instrument.

1. With the total station removed from tribrach, level tribrach with adjustment knobs until the bubble (A) is centered in the circular level. The bubble moves towards the screw that is turned clockwise.
2. Rotate tribrach 90° and adjust until bubble is centered in the circular level.
3. Repeat steps 1 and 2 until tribrach is level in both directions.
4. Carefully reinstall total station to tribrach. Secure with clamp and tribrach locking screw.
5. On total station keyboard, depress power button (B) to turn power on.
6. The electronic bubble (tilt) window will be displayed. If the electronic bubble window is not displayed, select tilt angle compensation icon (C).
7. Level total station using the tribrach leveling foot screws until the bubble is centered in the circular level.

NOTICE

When using the electronic display, make small changes and then let the readings stabilize before making another correction.

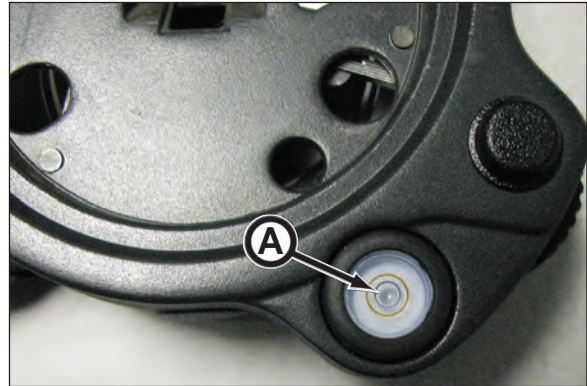
8. Once total station has been properly leveled, the tilt offset compensation range must be measured. Refer to Checking Tilt Offset in this section.
9. Perform collimation check. Refer to Checking Collimation in this section.

NOTICE

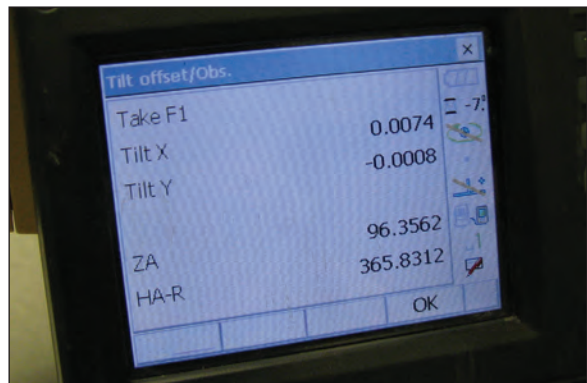
The tilt offset check and collimation should be performed once total station is delivered to job site, transported in a manner where the total station was subjected to strong vibration, or the instrument has been bumped.

(continued on next page)

az100-050107



TopCon® Total Station Sokkia® Total Station



10. Using the surveying marks on the edge of shaft, run a string line between these two marks to set the line of the total station.
11. Use two lines and plumb bobs to transfer the surveying marks to the shaft floor. Suspend the plumb bobs into a cup of oil to restrict the effects of air movement along the string lines. This will ensure a more accurate reading.

NOTICE

Be sure plumb bobs are free to move in oil. Do not allow the plumb bobs to touch the bottom or sides of the cups.

⚠ DANGER

Staring into laser light will cause severe injury. Do not stare into laser guidance system light beam. Avoid direct eye exposure.

To avoid possible exposure to radiation in excess of acceptable emission limits, all repairs to laser must be performed by the original manufacturer or an authorized service technician.

12. If desired to perform a preliminary setup, manually turn the total station laser on and line up the total station to the string lines as needed. The string alignment must be set within the software.
13. Proceed to System Setup Using AZ100 Software Program in this section.



String Line In Back of Launch Shaft



String Line In Front of Launch Shaft

ASSEMBLING THE PIPE STATION

NOTICE

The pipe station mount, self leveling tribrach and SNU can be assembled above ground in pipe. Do not install total station until it is actually required in tunnel to prevent damage.

1. Install expandable pipe band (A) into pipe that will contain the pipe station. Secure with pipe band tensioner bolt. Keep in mind, the guidance system side mount assembly MUST be within $\pm 5^\circ$ of level.
2. Mount SNU (not shown) as needed to install within 10 ft (3 m) of the total station.
3. Install self leveling tribrach (B) to side mount assembly.
4. Connect power and ethernet cables from MTBM front section box to SNU.

NOTICE

A power split box must be installed on the MTBM front section box that is not equipped with an 3 pin 120V power connections for the guidance system.

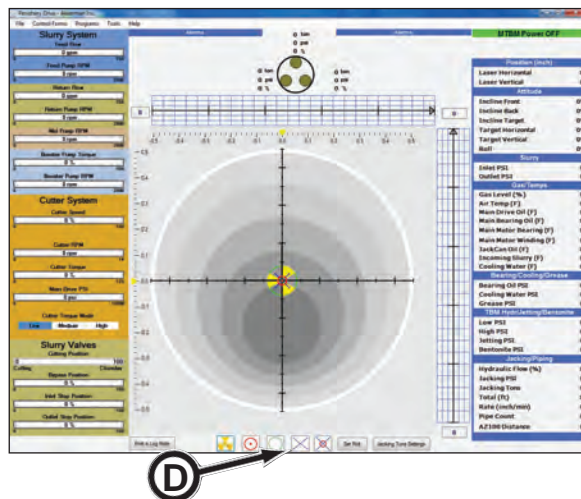
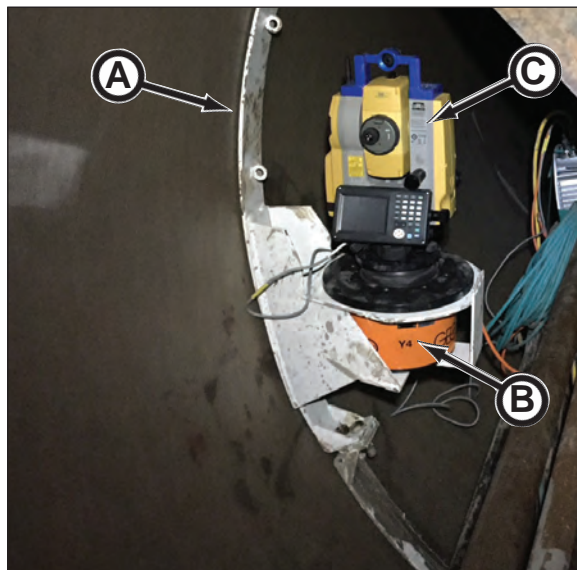
5. Connect communication cables from SNU to the self leveling tribrach.
6. Leave the total station in the protective case until it is actually required in tunnel to prevent damage while installing tunnel utilities.
7. Mount and secure the total station (C) to the self leveling tribrach.

The total station must be able to freely rotate in all directions. Also, be sure the total station is protected on all sides including area above theodolite to prevent damage from falling objects

8. Refer to System Setup Using The AZ100 Software Program in this section to configure the pipe station and software setup.

NOTICE

BEFORE adding the pipe station online, record and mark (with laser position marker [D]) the laser positions on the control screen. Once configured, check the recorded to current spot. If different, the alignment must be resurveyed. Be sure to keep the tunnel ventilation environment consistent ("steady state") for accurate laser positioning.



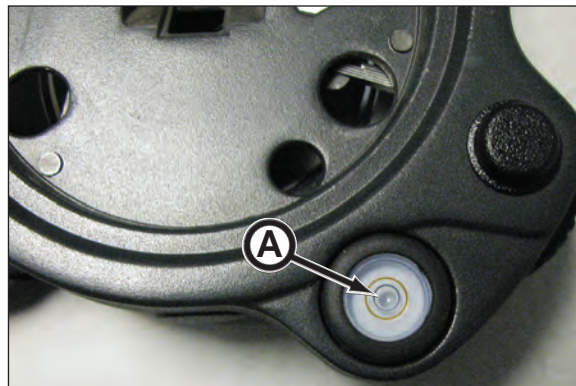
CHECKING TOTAL STATION TILT OFFSET

NOTICE

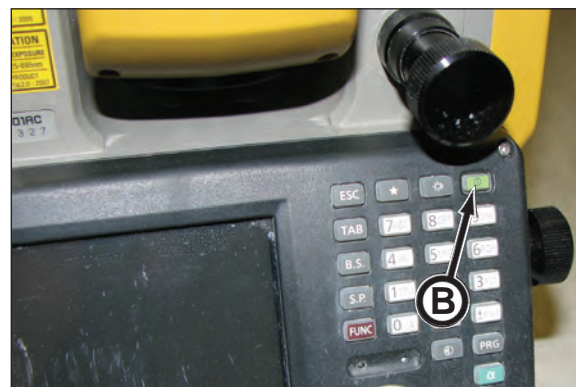
Refer to your Total Station instruction manual for more information on checking the tilt offset.

The tilt offset check should be performed once the total station is delivered to the job site, transported in a manner where the total station was subjected to strong vibration, or the instrument has been bumped.

1. Level tribrach with adjustment knobs until the bubble (A) is centered in the circular level. The bubble moves towards the screw that is turned clockwise.



2. Power on the total station by depressing power button (B).

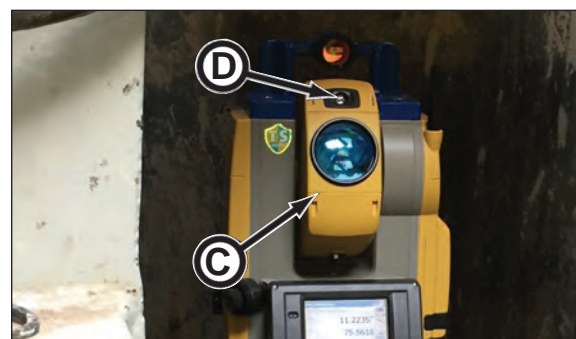


TopCon® Total Station



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3. Before checking tilt offset, be sure the sighting collimator (C) is in the proper position as shown with the guide light (D) at the top of the collimator. If the sighting collimator is not in the correct position, an error will occur.



(continued on next page)

- The electronic level window will be displayed.

Level total station using the tribrach leveling foot screws until the bubble is centered in the circular level. The bubble moves towards the screw that is turned clockwise.

NOTICE When using the electronic display, make small changes and then let the readings stabilize before making another correction.

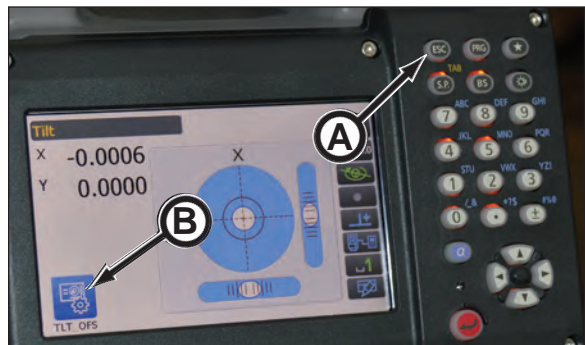
- Press the ESC key (A) to get to the main menu (or press TLT_OFS (B) on level window to go directly to the tilt offset window).



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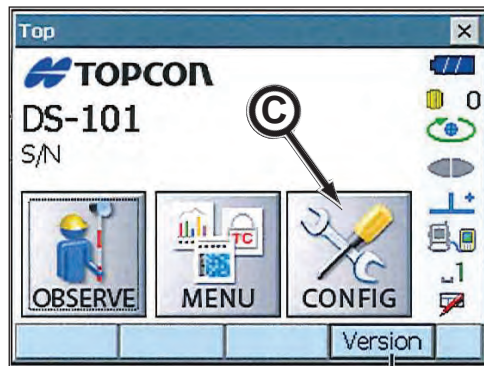


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- Select CONFIG (C).



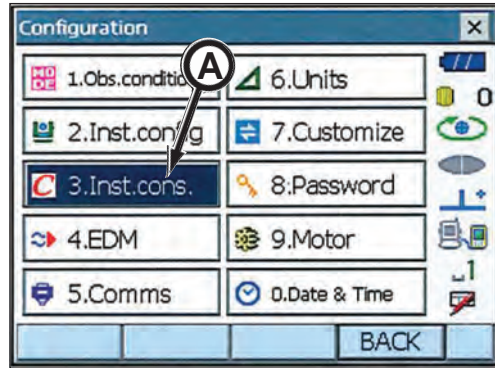
TopCon® Total Station



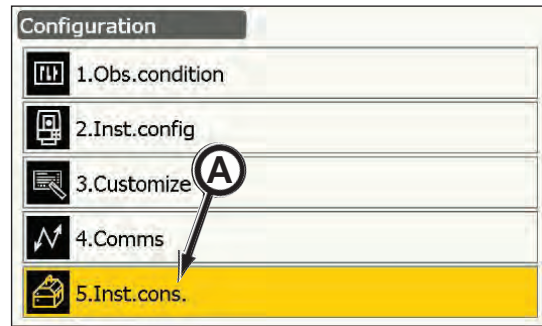
Sokkia® Total Station

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7. Select 3. Inst.cons (A).

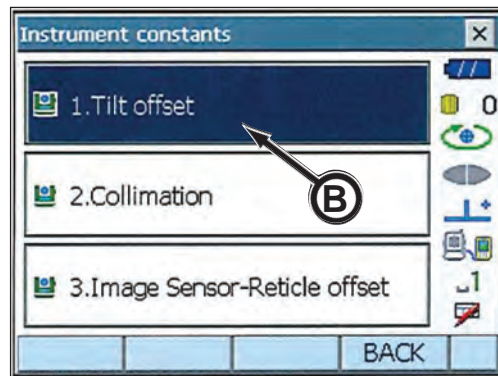


TopCon® Total Station

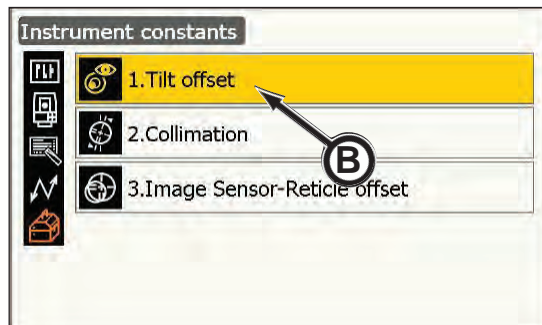


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8. Select 1. Tilt offset (B).



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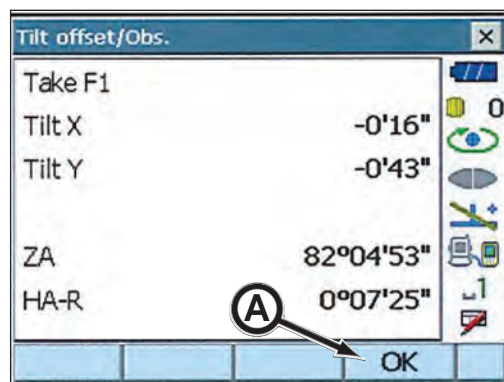


Sokkia® Total Station

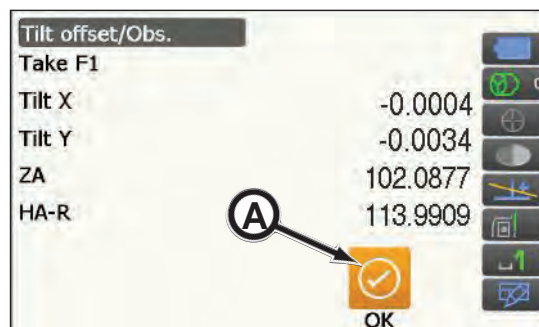
(continued on next page)

CAUTION Do not look through the telescope eyepiece after selecting OK. The motor drive will operate resulting in possible eye injury if struck by the rotating telescope.

9. Select OK (A). The top of the instrument and telescope will rotate 180° from the current position measuring F1 (Face 1).
10. Wait until the screen stabilizes.

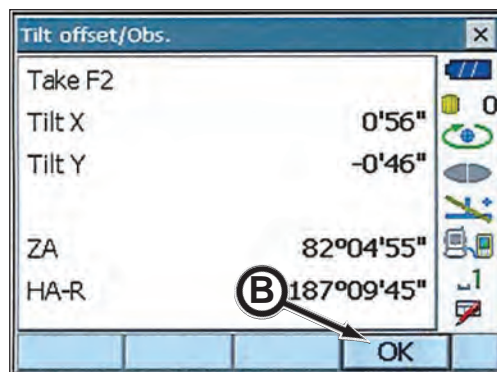


TopCon® Total Station

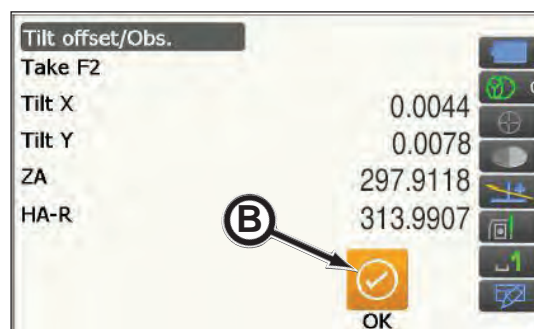


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11. Select OK (B) to automatically rotate the top of the instrument and the telescope 180° measuring F2 (Face 2).



TopCon® Total Station

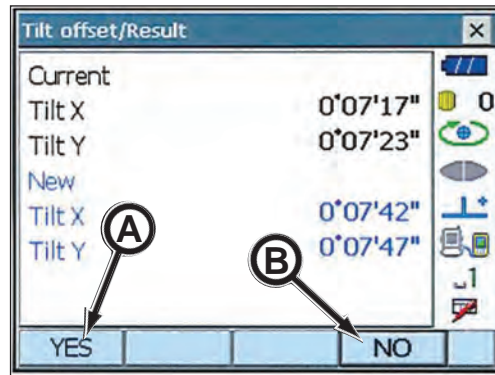


Sokkia® Total Station

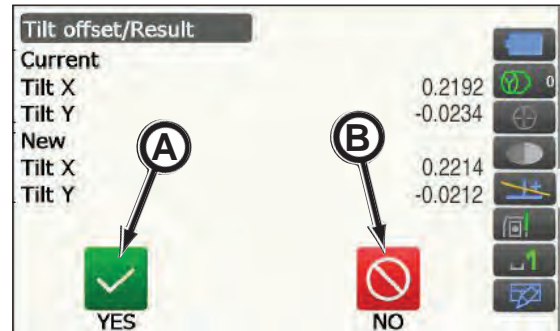
(continued on next page)

12. The tilt offset result will be displayed. Select YES (A) to accept the new correction angle.

- If tilt values greatly differ from previous values, select NO (B) and recheck total station level and tilt offset.
- If an error is displayed, the total station level and tilt offset must be rechecked.



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13. Proceed to the next procedure as follows:

- If the tilt offset check was performed when the total station was initially brought to the job site, proceed to Checking Collimation in this section.
- If the tilt offset check was performed after the total station was subjected to strong vibration or the instrument was bumped, proceed to Checking Collimation in this section.
- If checking tilt offset was performed after simply powering up total station, such as during mining, proceed to System Setup Using AZ100 Software Program in this section.

CHECKING COLLIMATION

NOTICE

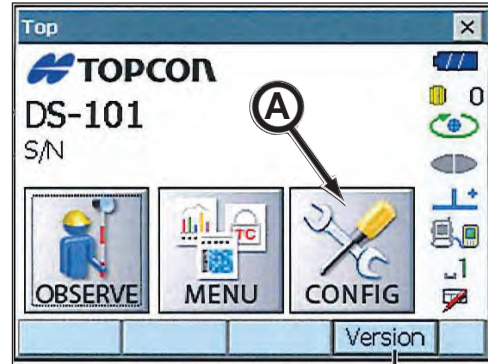
Refer to your Total Station instruction manual for more information on checking the collimation.

It is only necessary to perform the collimation check when the total station is initially brought to the job site, unless the total station is subjected to strong vibration, or the instrument has been bumped.

Once the tilt offset check is completed, the collimation (line of sight) check can be performed.

IMPORTANT: BEFORE checking collimation, be sure the sighting collimator is in the proper position with the guide light at the top of the collimator. If the sighting collimator is not in the correct position, an error will occur.

1. Press the ESC key to get to the main menu.
2. Select CONFIG (A).



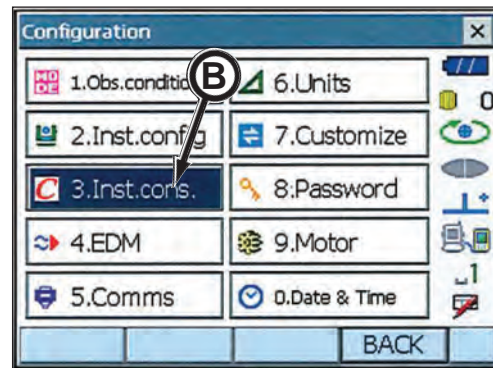
TopCon® Total Station



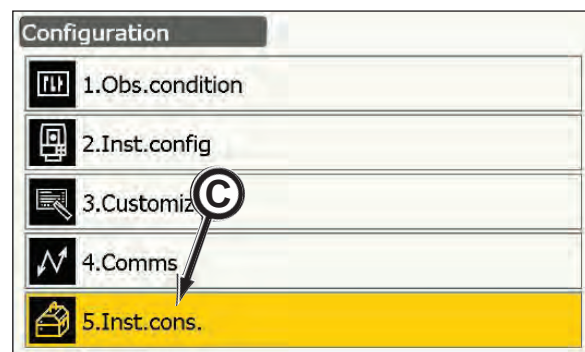
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3. TopCon Total Station: Select 3. Inst.cons (B).

Sokkia Total Station: Select 5. Inst.cons (C).



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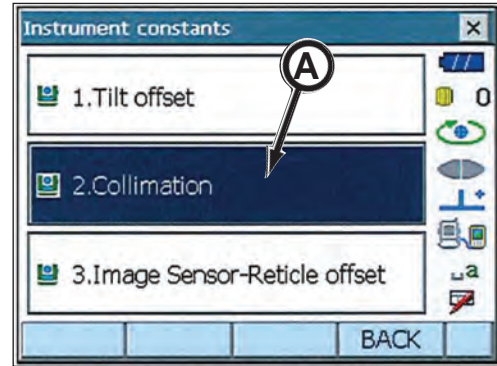


Sokkia® Total Station

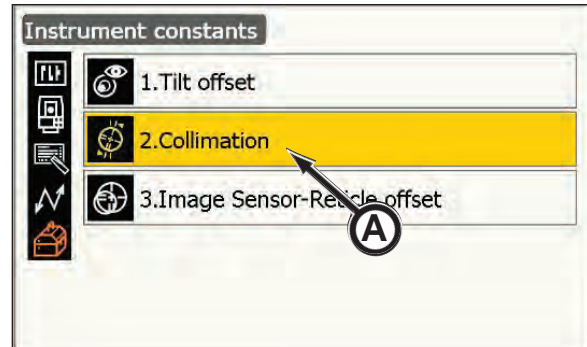
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4. Select 2. Collimation (A).

5. Manually sight the total station to a target (with a detailed reference point) that is a distance far enough to allow the telescope to visually position the cross hairs clearly on the target reference point.



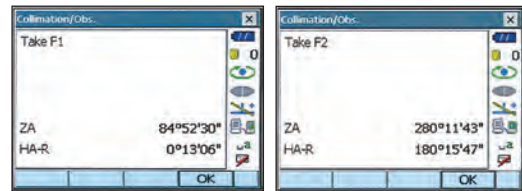
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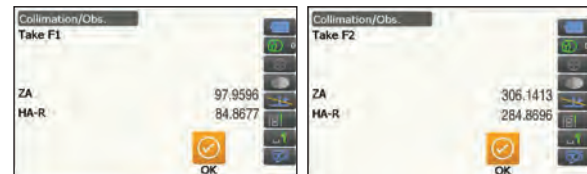
CAUTION Do not look through the telescope eyepiece after selecting OK. The motor drive will operate resulting in possible eye injury if struck by the rotating telescope.

6. Select OK. The telescope rotates and the vertical circle is indexed (Face 1).



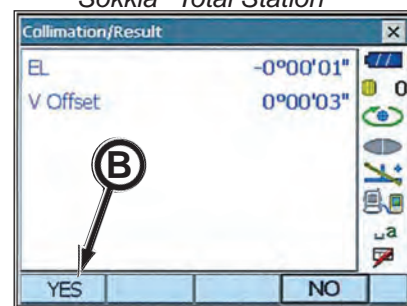
TopCon® Total Station

7. Once the total station has reorientated itself, manually sight the target to the same reference point (from step 5) and press OK. The telescope rotates and the vertical circle is indexed (Face 2).



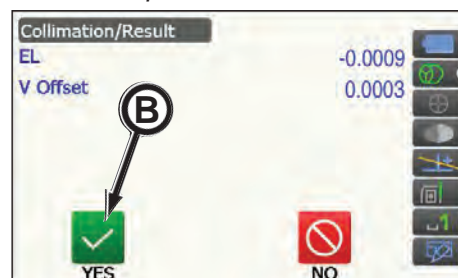
Sokkia® Total Station

8. The Collimation/Result window will appear. Press Yes (B) to set the constant.



TopCon® Total Station

9. The total station is now ready for use with the AZ100 software program. Proceed to System Setup Using AZ100 Software Program in this section.



Sokkia® Total Station

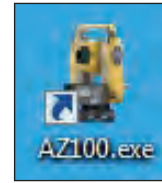
SYSTEM SETUP USING AZ100 SOFTWARE PROGRAM

IMPORTANT: Once the shaft station total station is initially brought to the job site, the Tilt Offset and Collimation must be checked. If subjected to strong vibration or instrument has been bumped, recheck.

1. Level and check the tilt offset compensation.



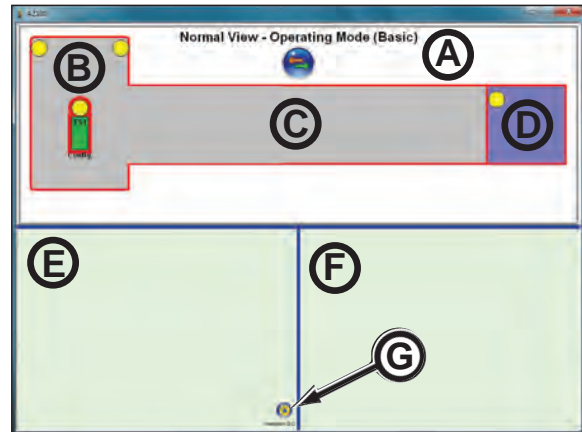
2. Install the AZ100 dongle into computer USB port,



3. Then boot up the AZ100 software program by double clicking the AZ100.exe icon on the desktop. The Normal View - Operating Mode screen will appear.

The main screen is divided into three sections:

- a. Tunnel View Pane (A)
 - shows a representation of the tunnel layout; launch shaft (B), tunnel (C) and tunnel boring machine (D).
- b. Control Pane (E)
 - shows various controls; controls will vary depending on mode selected.
- c. Information Pane (F)
 - shows general information about the currently selected item.

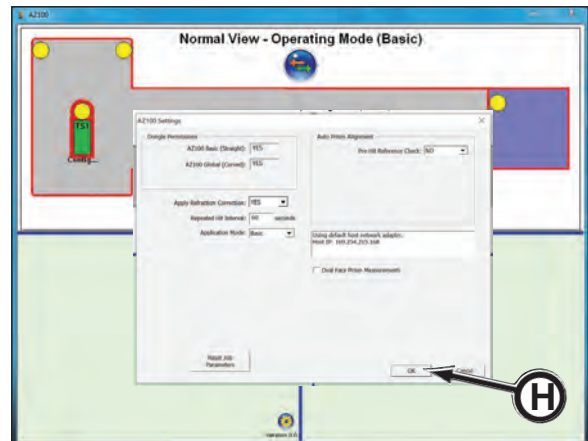


NOTICE The tunnel view pane contains a red border around the launch shaft, tunnel and TBM. This indicates that the areas have not been configured to the system or there is a problem with the item.

4. Once the main screen appears, click version icon (G) to verify the proper AZ100 settings as follows:

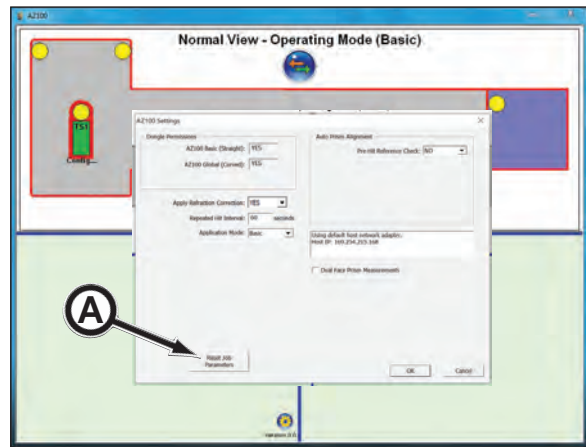
- | | |
|------------------------------|----------|
| AZ100 Basic (Straight): | YES |
| AZ100 Global (Curved): | YES |
| Apply Refraction Correction: | YES |
| Repeated Hit Interval: | 60* sec |
| | *default |
| Application Mode: | BASIC |

5. Click OK (H).

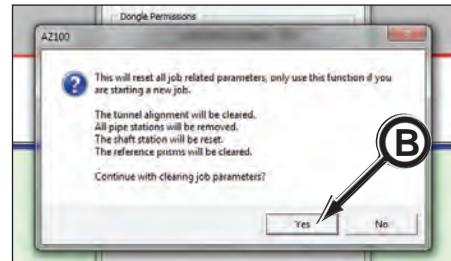


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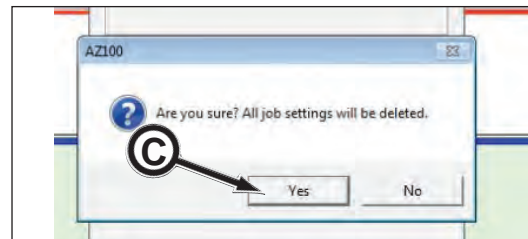
IMPORTANT: When starting a new tunnel project, be sure to clear previous tunneling project data from the AZ100 program by clicking Reset Job Parameters button (A). Failure to do so will result in utilizing incorrect data for the new tunnel project. Refer to Reset Job Parameters in this section.



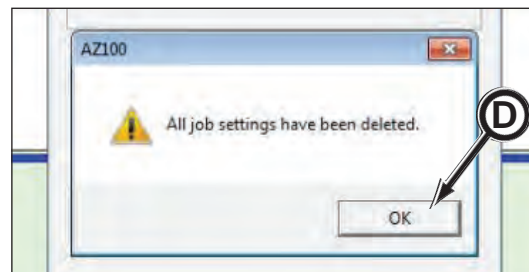
Click Yes button (B) to continue to clear job parameters.



Click Yes button (C) to confirm that all job settings will be deleted.



Click OK button (D) to return to AZ100 Settings window.

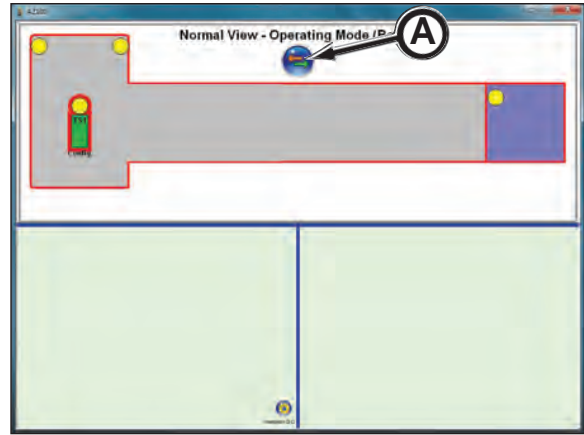


Click OK button (E).



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6. Click switch button (A) to change view from Normal View - Operating Mode to the Normal View - Setup Mode screen



7. Click on TS1 icon (B) and click information button (C). Enter data to configure TS1. This establishes communication to the shaft station.

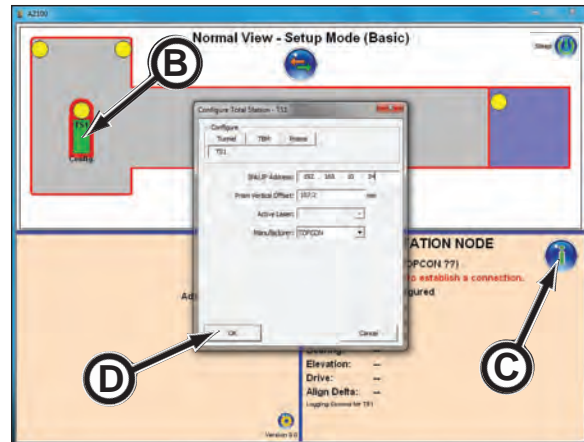
- a. The **SNU IP Address** will initially be displayed as 0.0.0.0. Enter the IP address labeled on the TS1 SNU.

- b. In the **Prism Vertical Offset** field, enter 107.2 mm when using the TOPCON DS-101AC Total Station. If using a different total station, contact your Akkerman Aftermarket Support representative for more information.

- c. The **Active Laser** field is for future use. Leave this field blank.

- d. In the **Manufacturer** field, select TOPCON.

8. Once the data has been entered, click OK (D). The software will now try to connect to the SNU. This may take up to 60 seconds.

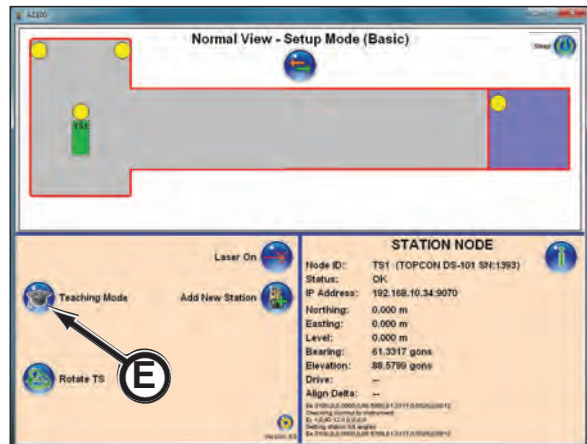


NOTICE If the TS1 icon is still shown with a red border and no connection has been established, then close and restart the software.

9. Once the connection is established, the TS1 is now configured and the TS1 icon no longer has a red border around it. The SNU data is shown in the Information pane and the Control pane provides various control buttons.

The coordinates of TS1 is always 0,0,0. The information pane also displays the communication activity between the software and TS1.

10. Click Teaching Mode button (E).



(continued on next page)

11. Use the software to set alignment to strings as described in the following steps (12 through 16).
12. If not already done so:
 - using the surveying marks on the edge of shaft, run a string line between these two marks to set the line of the total station (or use surveying stick with prism or laser detector).
 - use two lines and plumb bobs to transfer the surveying marks to the shaft floor. Suspend the plumb bobs into a cup of oil to restrict the effects of air movement along the string lines. This will ensure a more accurate reading.

NOTICE

Be sure plumb bobs are free to move in oil. Do not allow the plumb bobs to touch the bottom or sides of the cups.

⚠ DANGER

Staring into laser light will cause severe injury. Do not stare into laser guidance system light beam. Avoid direct eye exposure.

To avoid possible exposure to radiation in excess of acceptable emission limits, all repairs to laser must be performed by the original manufacturer or an authorized service technician.

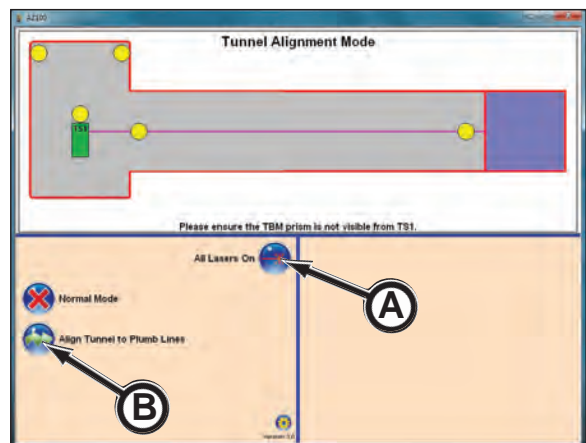


String Line In Back of Launch Shaft



String Line In Front of Launch Shaft

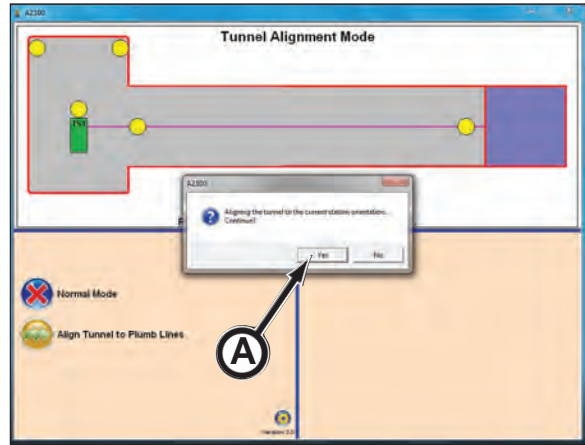
13. In the control pane, click All Lasers On button (A).
14. Manually align the shaft station laser to both string lines.
15. Once laser is properly aligned to both string lines, click Align Tunnel to Plumb Lines button (B).



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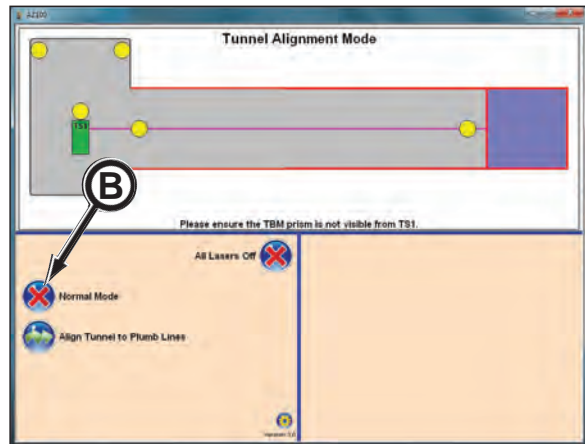
- Click Yes button (A) to confirm. The software will save this alignment setting.

NOTICE If the shaft station is moved after clicking the Align Tunnel to Plumb Lines, the alignment will not be accurate. Be sure to align laser to string lines BEFORE clicking the Align Tunnel to Plumb Lines.

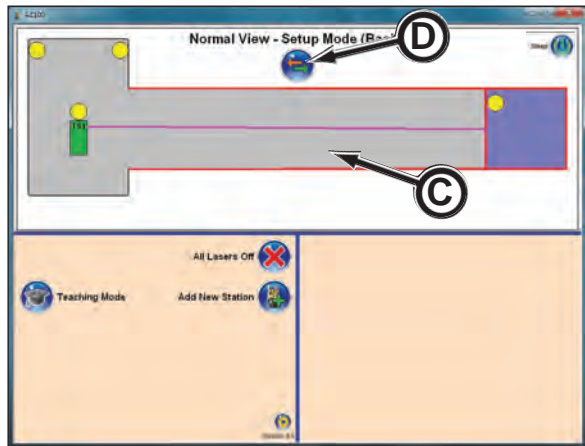


NOTICE Once the launch shaft is configured, the shaft will no longer have a red border around it.

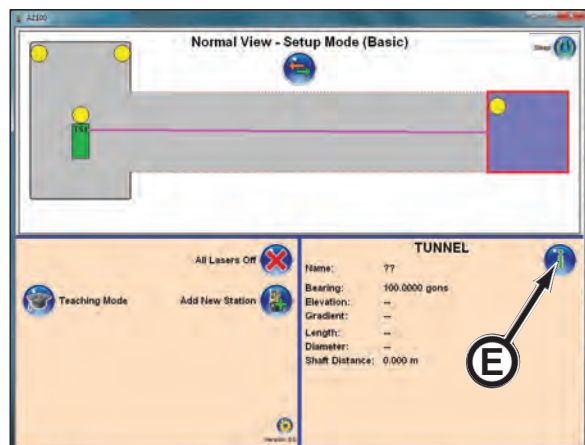
- Click Normal Mode button (B).



- In Normal View - Setup Mode screen, click tunnel area (C). If the Operation Mode screen is shown, click switch button (D) to switch to the Setup Mode screen.



- Click Information button (E).



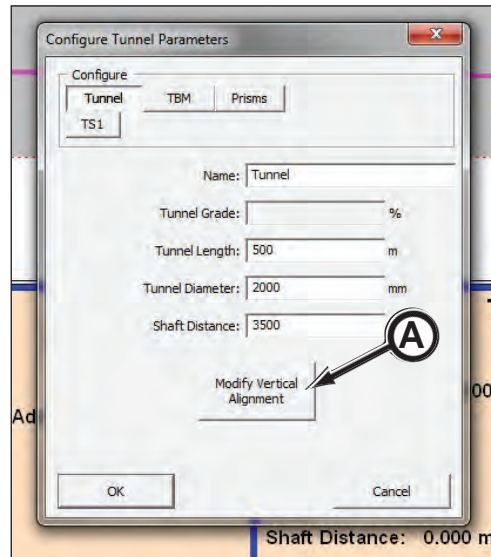
(continued on next page)

20. The Configure Tunnel Parameters window appears. Enter Name, Tunnel Length, Tunnel Diameter and Shaft Distance data.

- Type in **Name**: software stores a descriptive name of the tunnel - for information only.
- The **Tunnel Grade** will be entered in the Tunnel Alignment window (refer to step 22).
- Type in **Tunnel Length** in (m): software stores the length of the tunnel - the tunnel length distance is important for generating the required alignment length.

NOTICE The tunnel length value must be at least as long as the tunnel. If a smaller value is entered, when the TBM approaches the end of the tunnel, problems will occur.

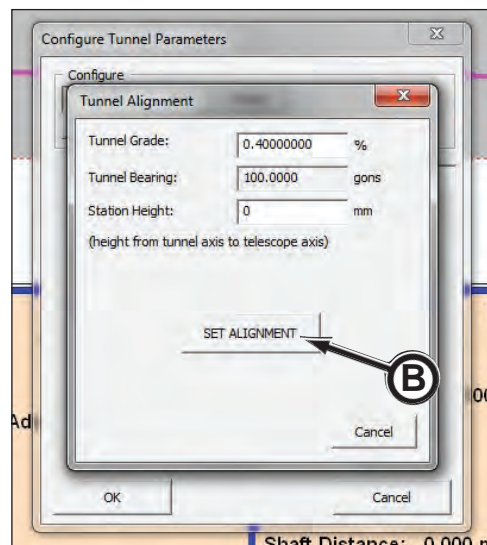
- Type in **Tunnel Diameter** in (mm): software stores the diameter of the tunnel - for information only.
- Type in **Shaft Distance** in (mm): software stores the distance of the shaft. If non-zero, the program will modify the displayed drive distance to the distance from the tunnel eye rather than the distance from shaft station (TS1).



21. Click Modify Vertical Alignment button (A). This will open the Tunnel Alignment window.

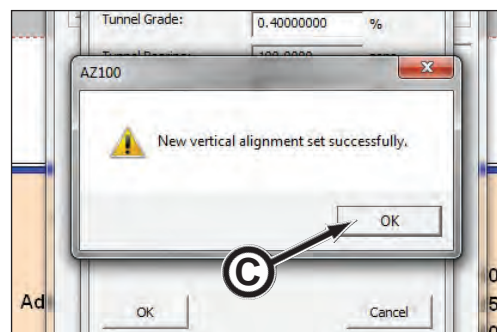
22. The Tunnel Alignment window appears. Enter Tunnel Grade and Station Height (height from tunnel axis to telescope axis).

- Type in **Tunnel Grade** in %.
- **Tunnel Bearing** field is for future use with the global coordinate system.
- Type in **Station Height**: enter height from tunnel axis to telescope axis. Typically, this field will be zero (0) since the shaft station telescope will be aligned to the tunnel axis. Can be used in instances if the line of sight is an issue.



23. Click Set Alignment button (B).

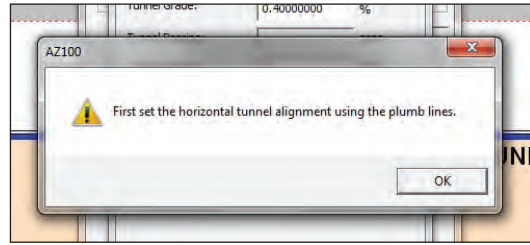
24. The New vertical alignment set successfully window appears. Click OK (C).



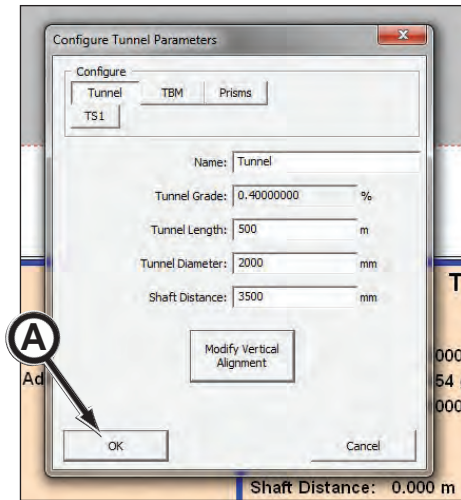
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NOTICE

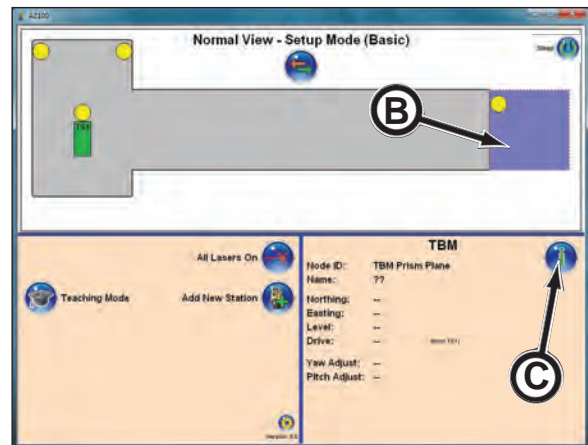
If the Align to Plumb Lines was not performed before configuring the tunnel parameters, the “First set horizontal alignment using the plumb lines” window will appear.



25. Click OK (A) to configure tunnel parameters. The shaft and tunnel red borders will disappear. This is a quick visual indicator that the shaft and tunnel are configured.



26. In Normal View - Setup Mode screen, click TBM area (B).



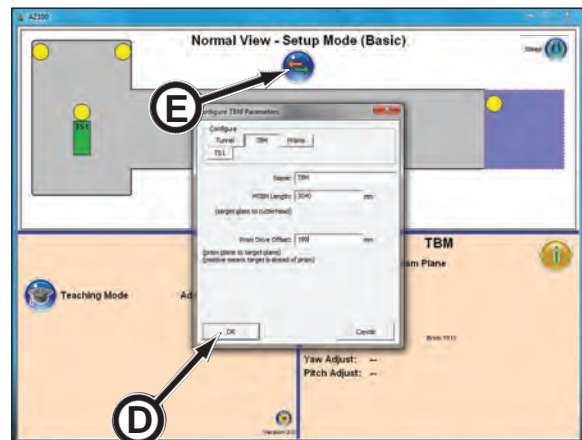
27. Click Information button (C).

28. The Configure TBM Parameters window appears. Enter Name, MTBM Length, and Prism Drive Offset data.

- Type in **TBM Name**.
- Type in **MTBM Length** (target glass to cutterhead). Enter length dimension in th. ft.
- Type in **Prism Drive Offset** (prism plane to target plane). Enter offset dimension in mm. Typically the offset is zero (0) unless prism is relocated.

29. Click OK (D).

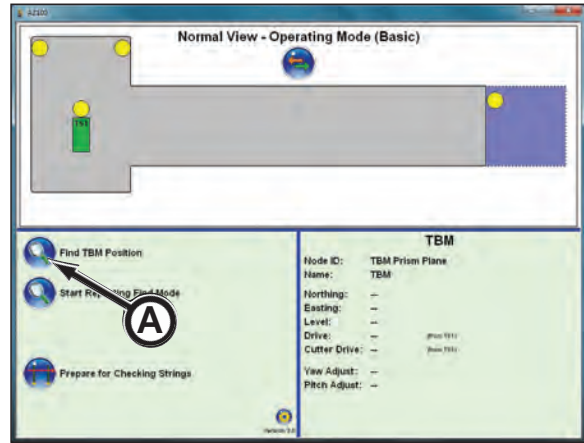
30. Click switch button (E) to change view to Normal View - Operating Mode.



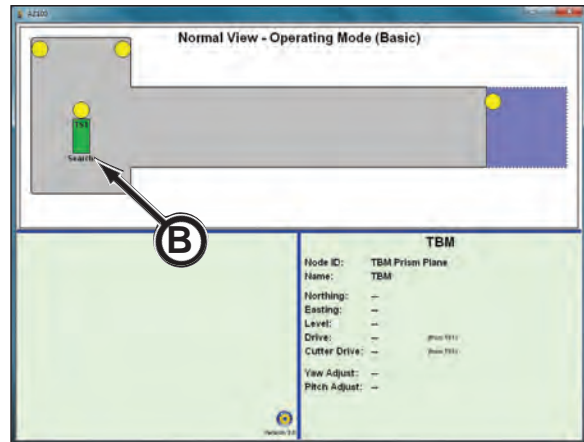
(continued on next page)

31. Establish the distance between the shaft station and the tunnel portal as follows:

- a. hold a prism near the center of portal.
- b. click Find TBM Position button (A).



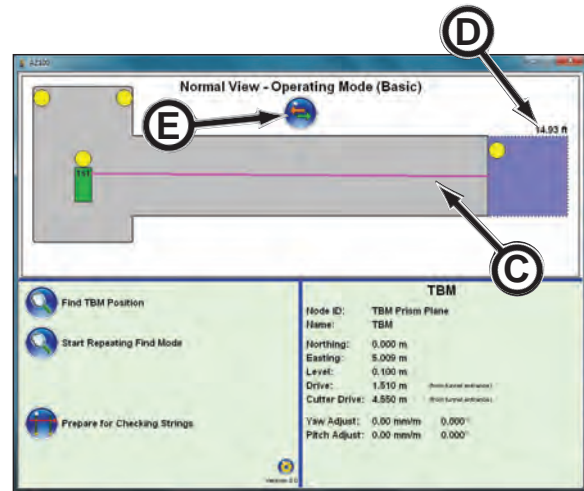
c. The TS1 icon will display status text (B) with a series of dots indicating it is in the process of finding the TBM (prism) position. The shaft station will turn and rotate until it locates the prism. If it is not able to find the prism, an error message will occur. Repeat process until TBM prism is located.



Status text under the station can be:

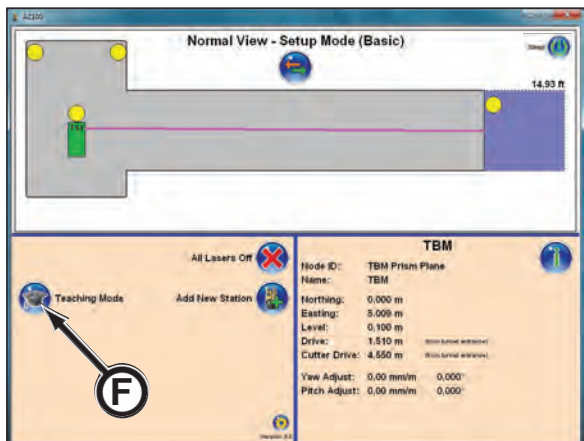
- **Config** - station is performing configuration commands
- **Searching** - Station is searching for a prism.
- **Turning** - station is being positioned.
- **Align** - station is aligning itself to a prism.
- **Waiting** - performing a task, waiting to complete.

d. Once the TBM position (temporary portal prism) is found, a line (C) will be displayed between the TS1 icon and the TBM.



The distance measurement (D) between the shaft station and the temporary portal prism is now shown above the TBM.

32. Click switch button (E) to change view to Normal View - Setup Mode.



33. Click Teaching Mode button (F).

(continued on next page)

34. The Tunnel Alignment Mode screen appears.

35. The reference prisms in the launch shaft must be configured for the system.

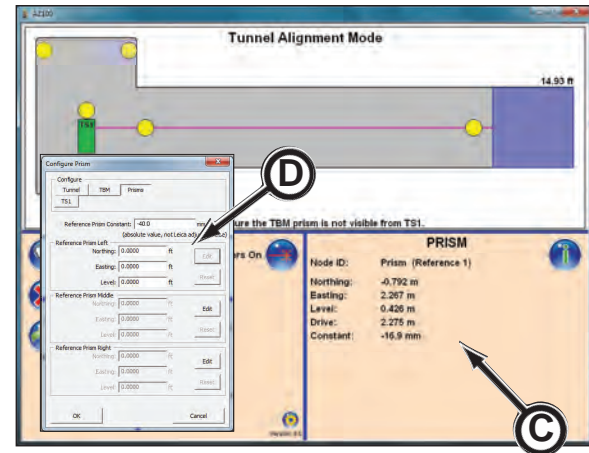
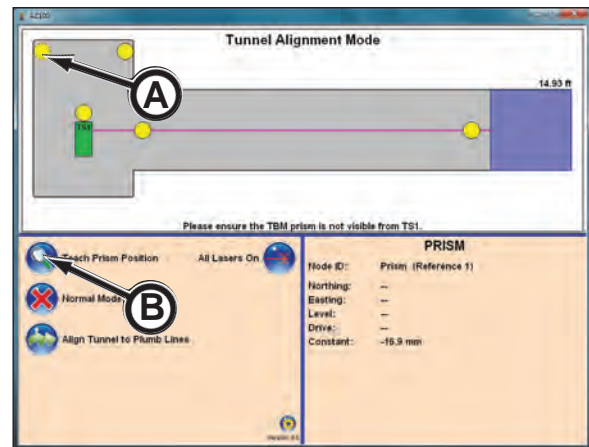
IMPORTANT: Shaft prisms purchased from Akkerman are -40 prism constants. If using a different style prism, you must verify and communicate the prism constant (the value is provided by the prism manufacturer) to Akkerman.

36. Click prism 1 icon (A).

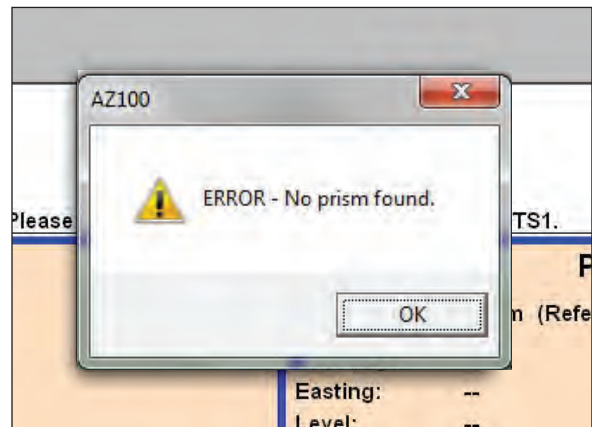
37. Physically turn the shaft station telescope towards prism 1 in launch shaft. Turn the laser ON to help line up the laser to the prism.

38. Click Teach Prism Position button (B).

39. The shaft station will turn and rotate until it locates prism 1. When the prism is found, the details will be shown in the Information pane (C) and are stored in the Configure Prism window (D).



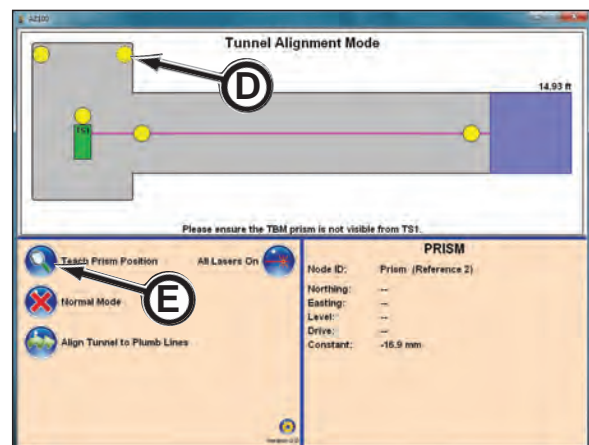
If the prism is not found, an “ERROR - No prism found.” window will appear. The prism will need to be reconfigured (repeat steps 36 through 39).



40. Click prism 2 icon (D).

41. Physically turn the shaft station telescope to prism 2. Turn the laser on to help line up the laser to the prism.

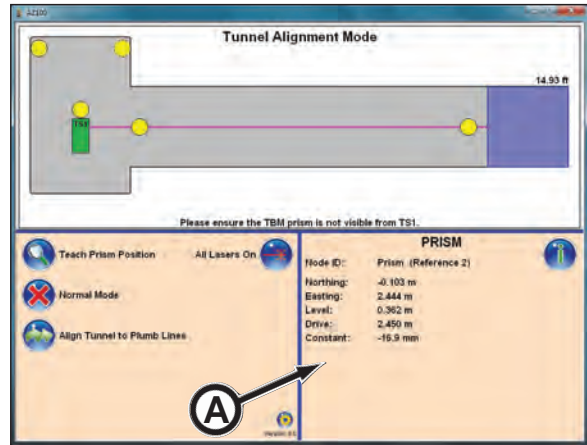
42. Click Teach Prism Position button (E).



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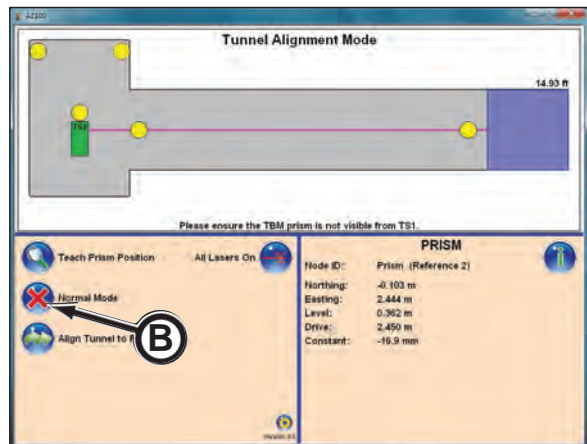
43. The shaft station will turn and rotate until it locates prism 2. When the prism is found, the details will be shown in the Information pane (A)

If the prism is not found, an “ERROR - No prism found.” window will appear. The prism will need to be reconfigured (repeat steps 40 through 43).



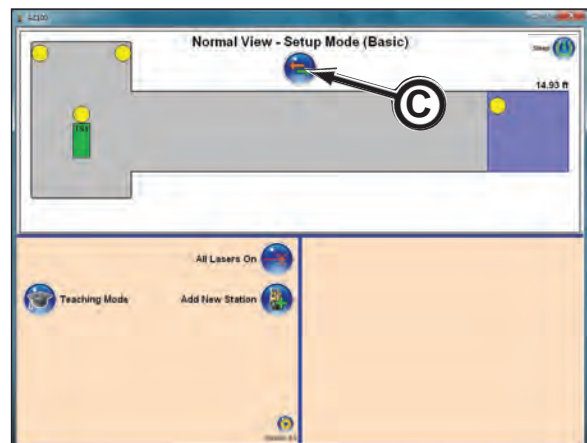
44. Once the MTBM is lowered onto jacking frame and launched so it will be possible for the shaft station to locate the reference prisms (must be in line of sight), click Normal Mode button (B).

NOTICE Target should be in installed in the MTBM.



45. The Normal View - Setup Mode screen appears.

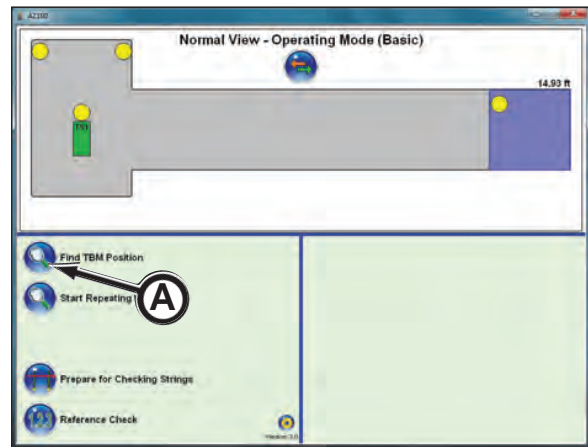
46. Click switch button (C) to change view to Operation Mode.



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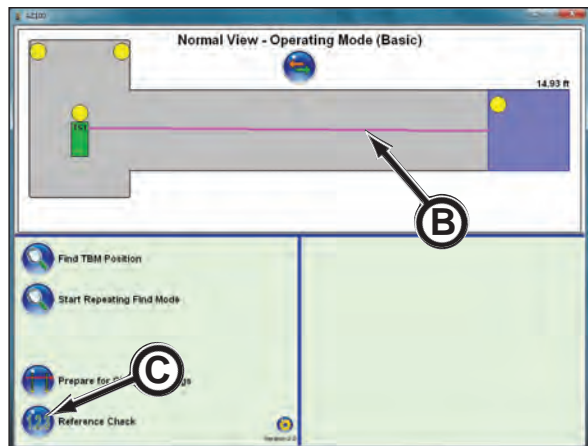
47. Click Find TBM Position button (A).

NOTICE During a position finding sequence, the pipeline and TBM must remain stationary. Keep thrust on the pipeline during this sequence.



48. Once the TBM position is found, a line (B) will be displayed between the TS1 icon and the TBM.

NOTICE While mining, it is recommended to click the Find TBM Position at each dog (relatching the jacking frame skid lock blocks) or approximately every 3 ft. Besides confirming the target position, the distance on the AZ100 screen.



49. At any time, the TS1 location can be checked for any movement. Click Reference Check button (C). Check the Reference Check at least at the end of every pipe.

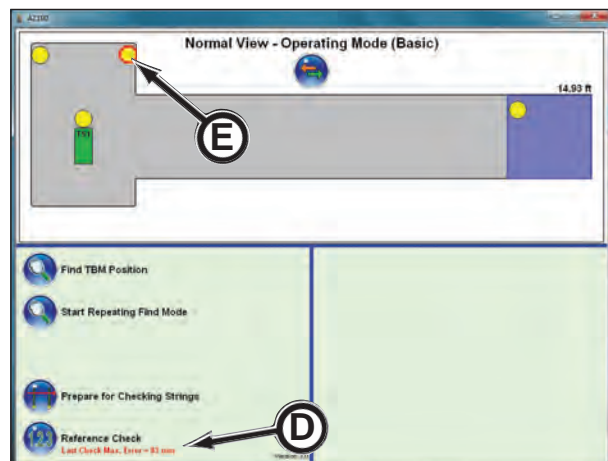
NOTICE To perform a Reference Check, the check needs to be done at the end of the pipe push:

- while there is still thrust pressure on the pipe for the most accurate target reading.
- so pipe and/or jacking frame thrust block will not interfere with the line of sight of reference prisms in launch shaft.

50. Once the Reference Check is complete, if an error is found, the “Last Check Max. error = mm” (D) will display in red and the prism(s) with the error will display with a red border (E).

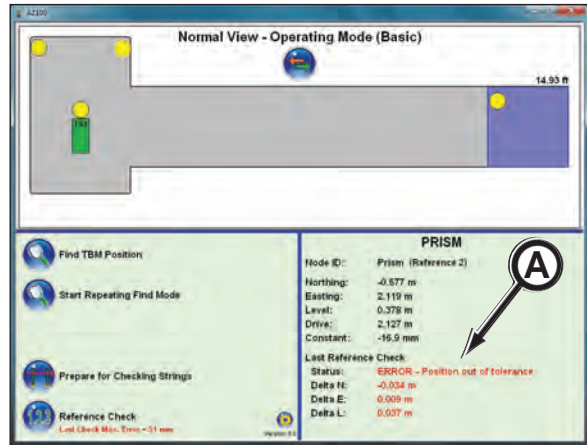
When a reference check error occurs, refer to Preparing for Checking Strings in this section.

NOTICE The reference check errors indicate that a prism or prisms are not in the original position. This could mean a prism moved or possibly the shaft station was bumped. In either case, the alignment must be reestablished by dropping string lines to be sure the total station is in proper alignment with the surveying marks. Then the prism positions will have to be realigned.



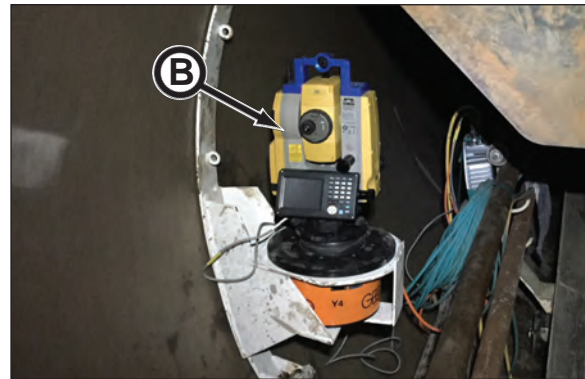
(continued on next page)

- Click the prism with the error (red border) to display the “ERROR - Position out of tolerance” (A) details in the Information pane.



51. Once you reach 150 - 250 ft (46 - 76 m), a pipe station (B) must be added to the pipe line. To install pipe station, refer to Assembling the Pipe Station in this section.

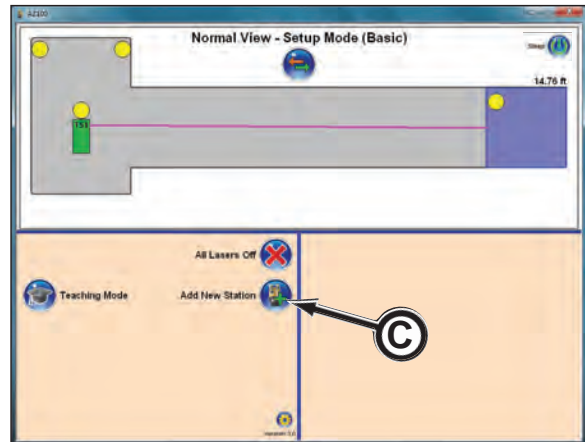
IMPORTANT: Once the pipe station total station is initially brought to the job site, the Tilt Offset and Collimation must be checked. If subjected to strong vibration or instrument has been bumped, recheck.



52. Be sure the pipe station telescope is pointing to the shaft station.

53. Access the Normal View - Setup Mode screen.

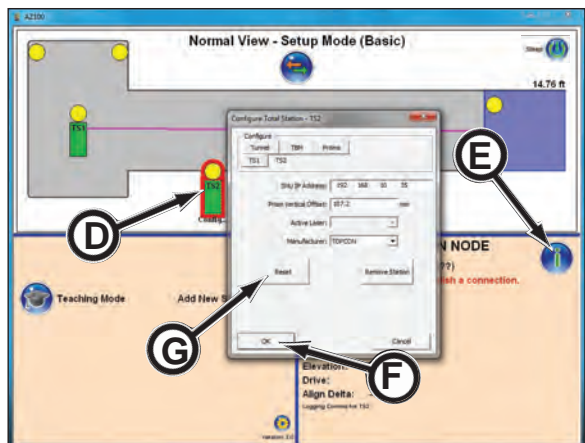
NOTICE BEFORE adding the pipe station online, record and mark the laser positions on the control screen. Once configured, check the recorded to current spot. If different, the alignment must be resurveyed.



54. Click Add New Station button (C).

55. Click on TS2 icon (D) and click Information button (E). Enter data to configure TS2. This establishes communication to the pipe station.
SNU IP Address: refer to label on SNU
Prism Vertical Offset: 107.2 mm
Active Laser: leave blank
Manufacturer: TopCon

NOTICE There are two extra buttons on the Configure TS2, TS3... windows. **Reset (G)**; deletes the stored position information so the system will retry to find the station. If reset, the station will need to be manually pointed backwards towards the previous station. Remove Station; any station except TS1 can be removed from the system.



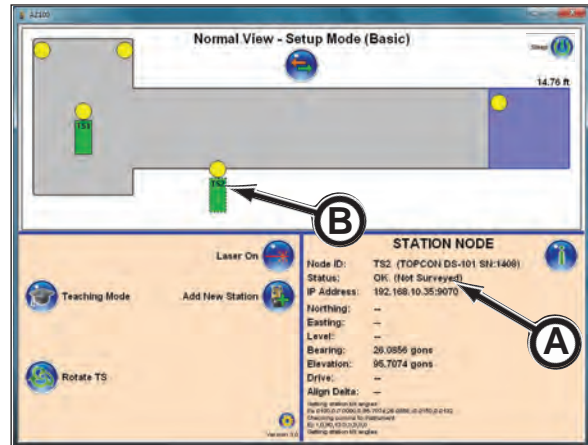
56. Once the data has been entered, click OK (F). The software will now try to connect to the SNU. This may take up to 60 seconds.

(continued on next page)

NOTICE If the pipe station icon remains with a red border and no connection is established after 60 seconds, then the software should be closed and restarted.

57. Once the connection is established, the pipe station is now configured but not aligned to the tunnel as shown in the graphic pane along with the Station Node status (A) that it is OK but not surveyed.

The TS2 icon (B) is shown outside of tunnel, not centered within tunnel. Proceed to step 58 to align TS2 in the tunnel.

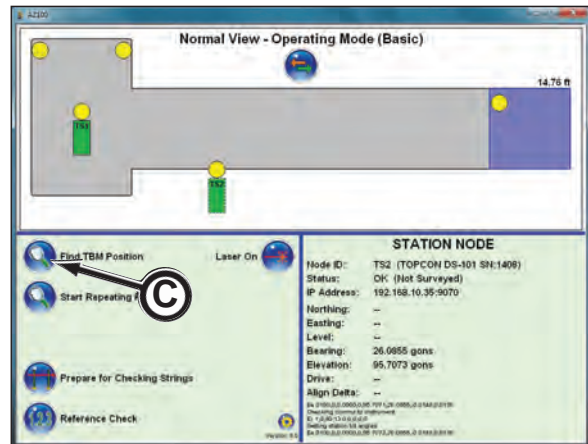


58. Access the Normal View - Operating Mode screen.

NOTICE When pipe stations are utilized, the shaft station (TS1) must **NOT** be able to see the TBM prism when it looks down the tunnel.

NOTICE During a position finding sequence, the pipeline and TBM must remain stationary. Keep thrust on the pipeline during this sequence.

59. Click Find TBM Position button (C). The two total stations will work together to establish the alignment between the two stations, then the TS2 will rotate to find the TBM position.



(continued on next page)

60. Once the TBM position is found, a line (A) from TS2 to the TBM is displayed. An error will be displayed if the TBM position was not found.

NOTICE The TS2 is centered in tunnel indicating it is configured properly.

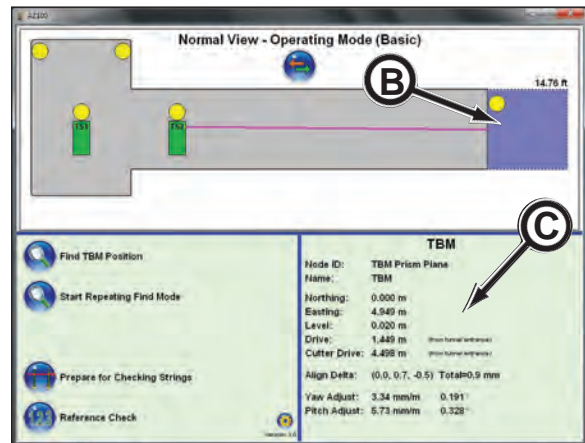
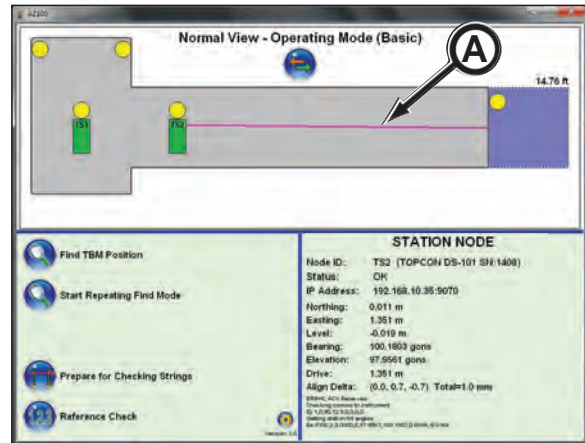
61. Click TBM graphic (B) to display TBM data such as yaw, pitch and other alignment data (C).

NOTICE As the MTBM advances, the positions of the moving stations will change to represent where they are located in the tunnel.

62. BEFORE shutting down Head Power during a new pipe set and utilities (refer to your Microtunneling Operator's Manual, Adding New Pipe & Utilities in the Operation section), it is a good practice to place the total stations into Sleep Mode and is recommended when there are four or more total stations in the tunnel. Sleep mode allows the total stations to complete any background tasks before shutting off power to prevent data corruption. Refer to Using Sleep Mode in this section.

63. Add additional pipe stations as needed. This is dependent on the tunnel environment. Typically another pipe station should not be required before 2,000 ft. (609 m), though the shaft station and the pipe station must be within line of sight. Curve tunnels will require additional pipe stations.

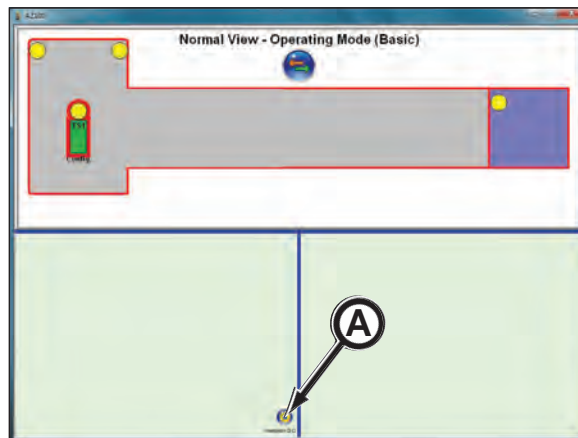
Also, if the shaft station and the pipe station cannot communicate between themselves, an additional pipe station is required.



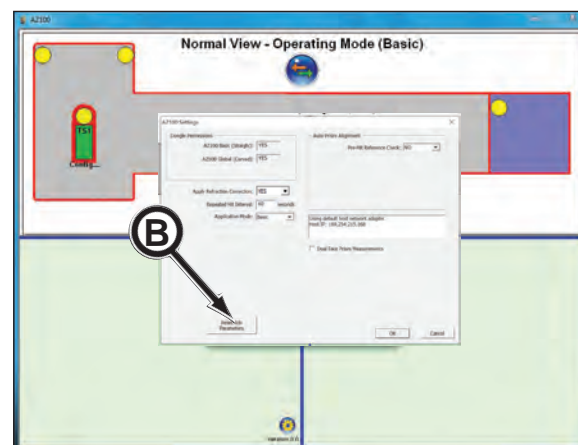
RESET JOB PARAMETERS

When starting a new tunnel project, be sure to clear previous tunneling project data from the AZ100 program. Failure to do so will result in utilizing incorrect data for the new tunnel project.

1. With the dongle in the computer USB port, boot up the AZ100 software program by double clicking the AZ100.exe icon on the desktop. The Normal View - Operating Mode screen will appear.
2. Once the main screen is visible and existing data from a previous tunneling project appears, click the settings version icon (A).



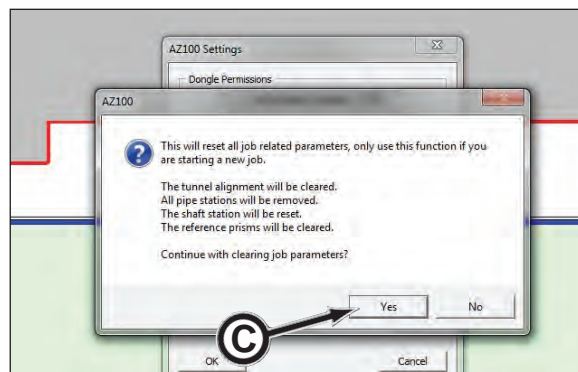
3. The AZ100 Settings window appears. Click Reset Job Parameters button (B).



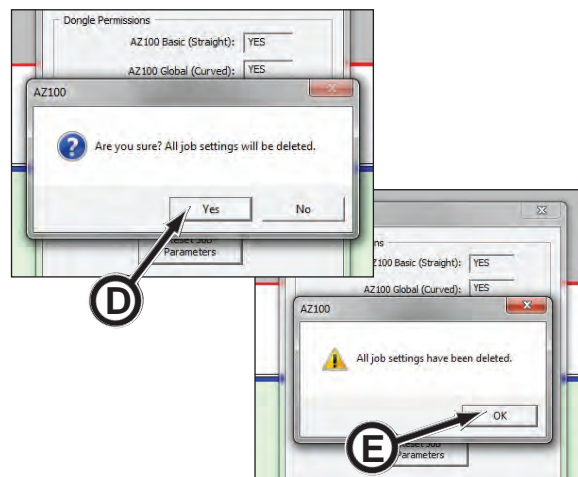
4. The “This will reset all job related” window appears. Click Yes (C).

Performing this function will reset all job related parameters:

- Tunnel alignment will be cleared.
- All pipe stations will be removed.
- The shaft station will be reset.
- The reference prisms will be cleared.



5. The “Are you sure?...” window appears. Click Yes (D) to confirm the existing data will be deleted.



6. The “All job settings have been deleted.” window appears. Click OK (E).

7. The job parameters are now reset. Proceed to System Setup Using AZ100 Software Program in this section.

ALIGN TUNNEL TO PLUMB LINES

Use the Align Tunnel to Plumb Lines to set tunnel alignment to the survey strings as follows:

1. Using the surveying marks on the edge of shaft, run a string line between these two marks to set the line of the total station (or use surveying stick with prism or laser detector).
2. Use two lines and plumb bobs to transfer the surveying marks to the shaft floor. Suspend the plumb bobs into a cup of oil to restrict the effects of air movement along the string lines. This will ensure a more accurate reading.

NOTICE

Be sure plumb bobs are free to move in oil. Do not allow the plumb bobs to touch the bottom or sides of the cups.

⚠ DANGER

Staring into laser light will cause severe injury. Do not stare into laser guidance system light beam. Avoid direct eye exposure.

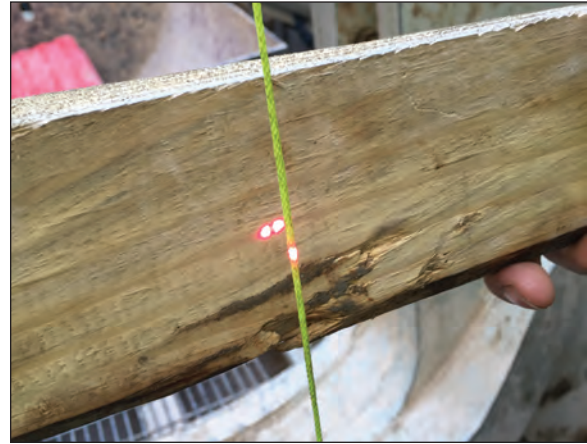
To avoid possible exposure to radiation in excess of acceptable emission limits, all repairs to laser must be performed by the original manufacturer or an authorized service technician.

3. In the control pane, click All Lasers On button (A).
4. Manually align the shaft station laser to both string lines.
5. Once BOTH string lines are properly aligned with laser, click Align Tunnel to Plumb Lines button (B).

NOTICE

Be sure to align laser to string lines BEFORE clicking the Align Tunnel to Plumb Lines button. Realigning shaft station after clicking button will result in an inaccurate alignment.

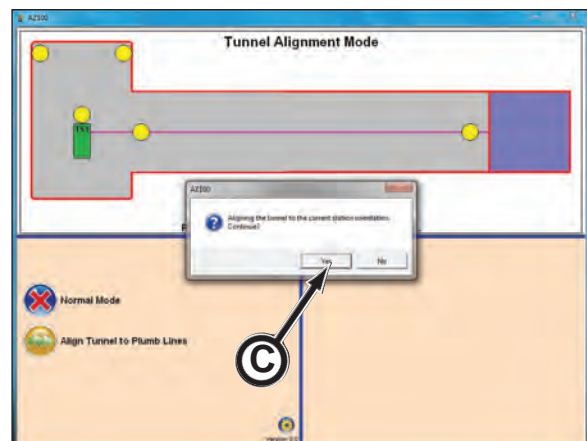
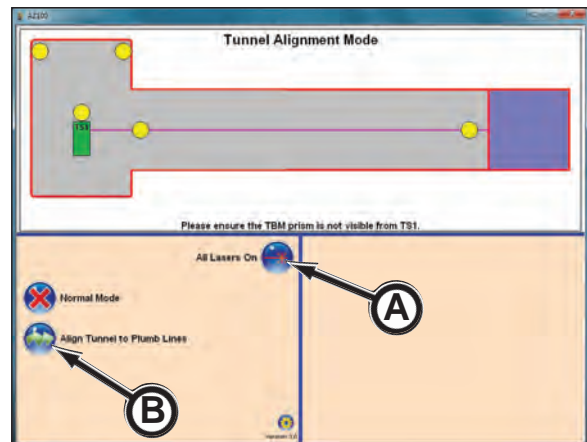
6. Click Yes button (C) to confirm alignment. The software will save this alignment setting.
7. If shaft station was moved to align with string lines, the reference prisms MUST be reset (retought). Refer to Setting Reference Prism Positions in this section.
8. Once tunnel is aligned and the reference prisms are configured, click the Find TBM Position button on the Operating Mode screen, refer to Finding TBM Position in this section.



String Line In Back of Launch Shaft



String Line In Front of Launch Shaft



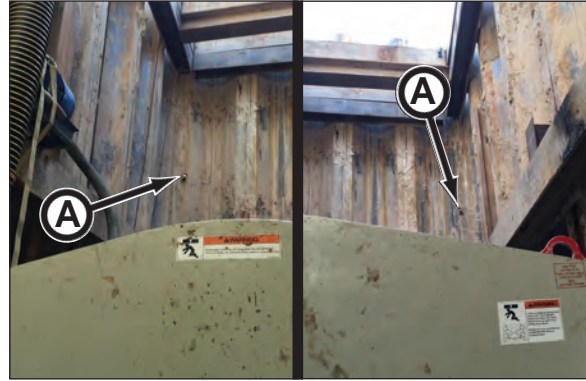
Operation

NOTES

SETTING REFERENCE PRISM POSITIONS

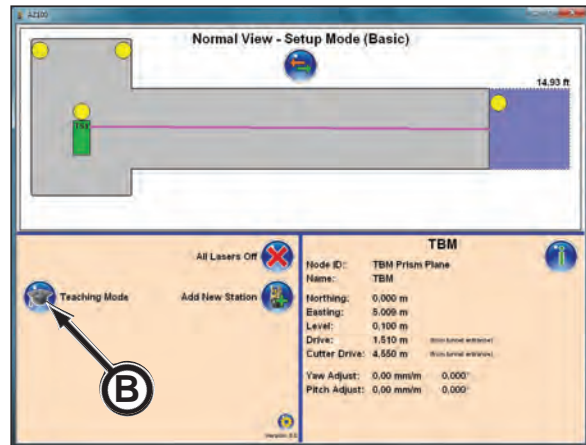
When the shaft station is properly aligned to the tunnel line, the reference prisms (A) must be configured for the system as follows:

IMPORTANT: Shaft prisms purchased from Akkerman are -40 prism constants. If using a different style prism, you must verify and communicate the prism constant (the value is provided by the prism manufacturer) to Akkerman.

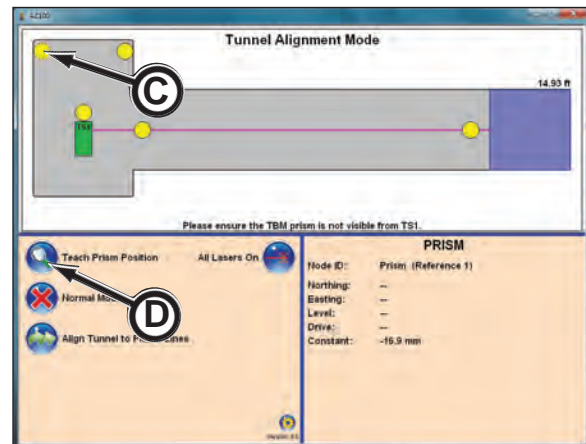


Shaft Reference Prisms

1. Access the Normal View - Setup Mode screen and click the Teaching Mode button (B).

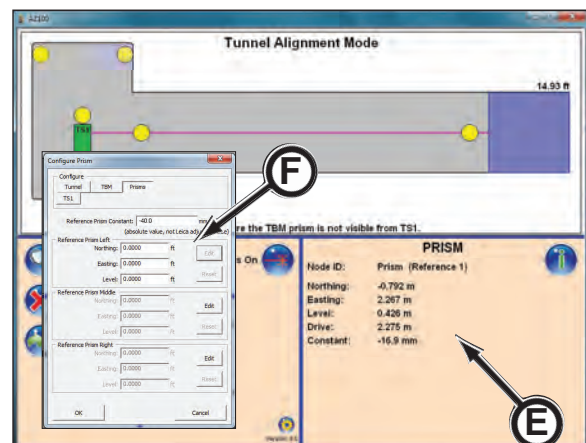


2. Click prism 1 icon (C).



3. Physically turn the shaft station telescope towards prism 1 in launch shaft. Turn the laser ON to help line up the laser to the prism.

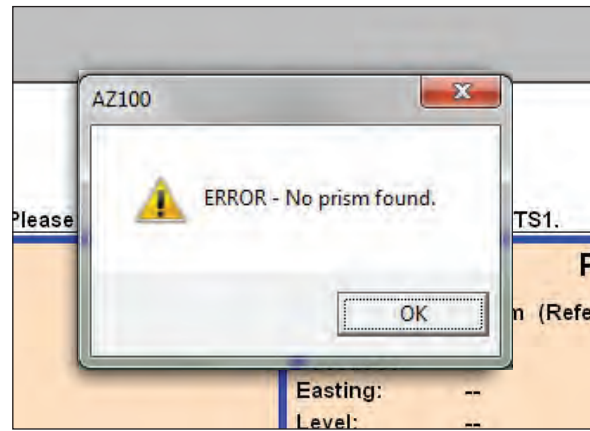
4. Click Teach Prism Position button (D).



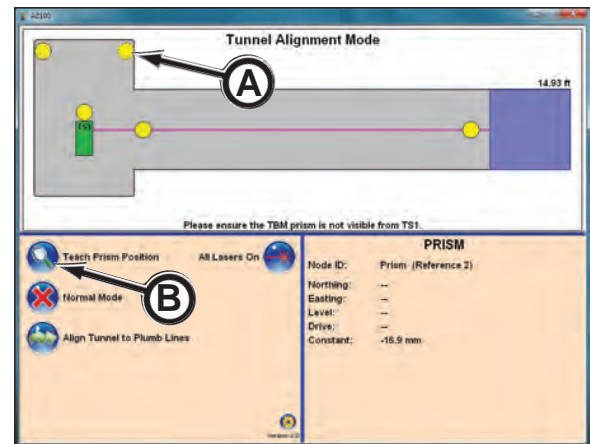
5. The shaft station will turn and rotate until it locates prism 1. When the prism is found, the details will be shown in the Information pane (E) and are stored in the Configure Prism window (F).

(continued on next page)

If the prism is not found, an “ERROR - No prism found.” window will appear. The prism will need to be reconfigured (repeat steps 1 through 5).

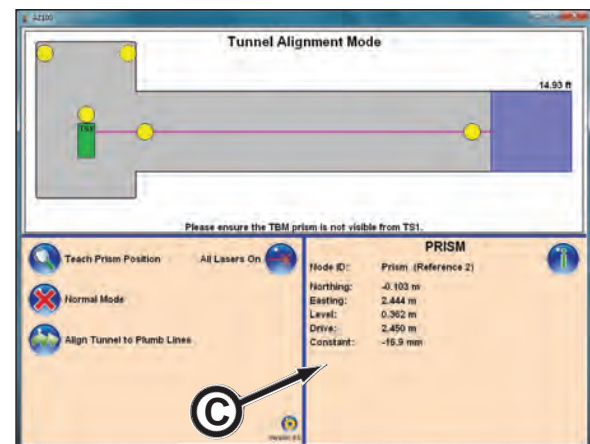


6. Click prism 2 icon (A).
7. Physically turn the shaft station telescope to prism 2. Turn the laser on to help line up the laser to the prism.
8. Click Teach Prism Position button (B).



9. The shaft station will turn and rotate until it locates prism 2. When the prism is found, the details will be shown in the Information pane (C)

If the prism is not found, an “ERROR - No prism found.” window will appear. The prism will need to be reconfigured (repeat steps 6 through 9).



FINDING TBM POSITION

Once the tunnel alignment is completed and TBM prism is installed, the locating of the TBM target prism can be attempted by clicking the Finding TBM Position button.

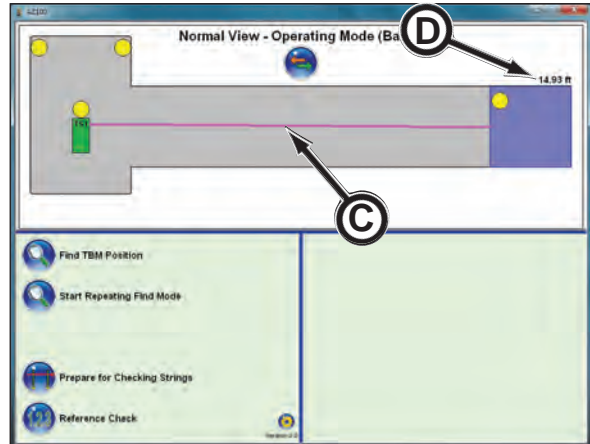
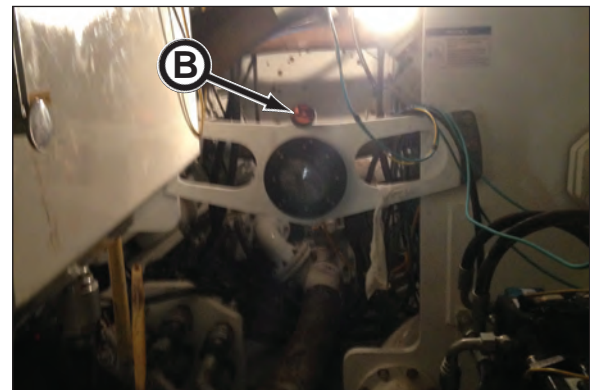
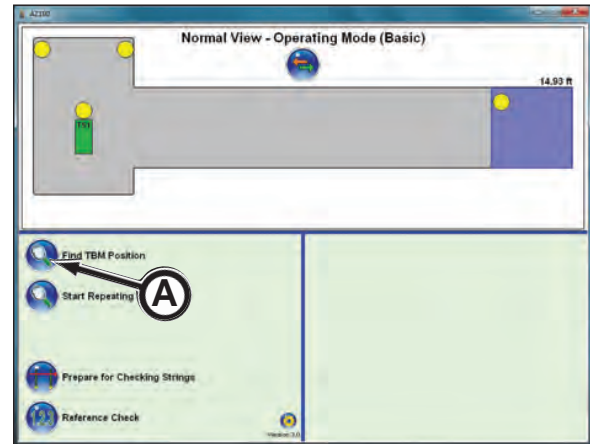
It is recommended, while mining, to click the Find TBM Position button at each dog (relatching the jacking frame skid lock blocks) or approximately every 3 ft. (1 m). Besides confirming the target position, the distance on the AZ100 screen will be updated.

NOTICE

During a position finding sequence, the pipeline and TBM must remain stationary. Keep thrust on the pipeline during this sequence.

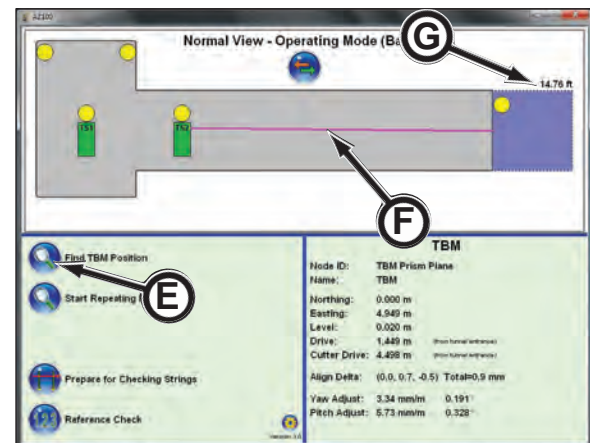
Finding TBM Position SHAFT STATION

1. In the Normal View - Operating Mode screen, click Find TBM Position button (A).
2. The TS1 icon will display status text with a series of dots underneath the icon, indicating it is in the process of finding the TBM prism (B) position. The shaft station will turn and rotate until it locates the prism. If it is not able to find the prism, an error message will occur. The tunnel alignment may have to be reset, refer to Align Tunnel to Plumb Lines in this section.
3. Once the TBM position is found, a line (C) will be displayed between the TS1 icon and the TBM.
4. The distance measurement (D) between the shaft station and TBM prism is displayed above the TBM in the tunnel view pane.



Finding TBM Position SHAFT STATION - PIPE STATION

1. In the Normal View - Operating Mode screen, click Find TBM Position button (E).
2. The two total stations (TS1, TS2) will work together to establish the alignment between the two stations, then the TS2 will rotate to find the TBM position.
3. Once the TBM position is found, a line (F) from TS2, or TS3 .. to the TBM is displayed. An error will be displayed if the TBM position was not found. The tunnel alignment may have to be reset, refer to Align Tunnel to Plumb Lines in this section.
4. The distance measurement (G) between the shaft station and TBM prism is displayed above the TBM in the tunnel view pane.

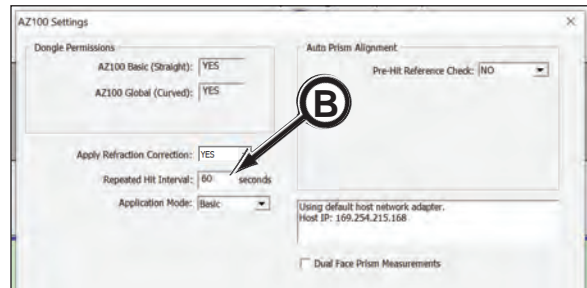
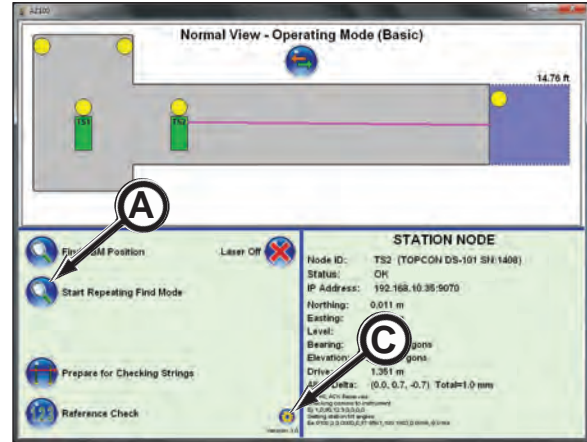


START REPEATING FIND MODE

The Start Repeating Find Mode (A) will perform the Find TBM Position repeatedly per the time interval indicated on the AZ100 Setting window, Repeated Hit Interval (B). This interval can be changed at any time by clicking on the version icon (C) and changing the number based on seconds.

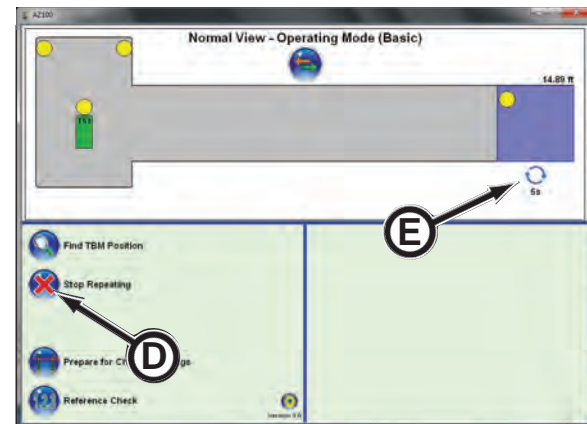
Personnel will have to be removed from the area while the positioning sequence is active due to the laser light.

Typically, operator's use the Find TBM Position button as needed so as to not interrupt the work being performed inside the tunnel.



When the operator wants to stop the repeating find mode sequence, click the Stop Repeating button (D).

The tunnel view pane shows the repeat mode icon (E) with the remaining time in seconds shown when the sequence will repeat.



PERFORMING REFERENCE CHECKS

A reference check is the sequence of checking the accuracy of the two reference prisms (A) in the launch shaft.

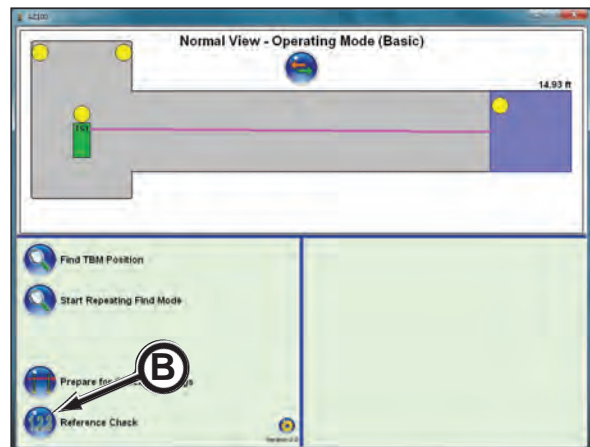
NOTICE To perform a Reference Check, the check needs to be done at the end of the pipe push:

- while there is still thrust pressure on the pipe for the most accurate target reading.
- so pipe and/or jacking frame thrust block will not interfere with the line of sight of reference prisms in launch shaft.

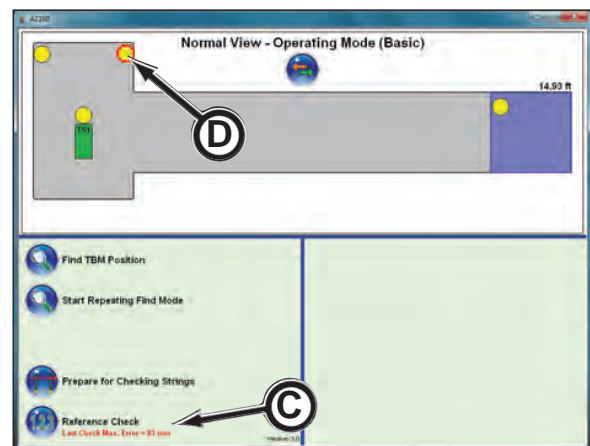


Shaft Prisms

1. At any time when there is thrust pressure on the pipe, the reference prism locations can be checked for any movement. Click Reference Check button (B). Check the Reference Check at least at the end of every pipe.



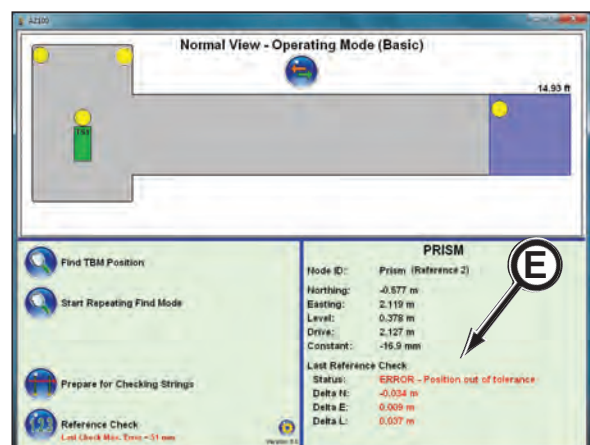
2. Once the Reference Check is complete, if an error is found, the "Last Check Max. error = mm" (C) will display in red and the prism(s) with the error will display with a red border (D).



NOTICE The reference check errors indicate that a prism or prisms are not in the original position. This could mean a prism moved or possibly the shaft station was bumped. In either case, the alignment must be reestablished by dropping string lines to be sure the total station is in proper alignment with the surveying marks. Then the prism positions will have to be realigned.

3. When a reference check error occurs, refer to Preparing for Checking Strings in this section.

- Click the prism with the error (red border) to display the "ERROR - Position out of tolerance" (E) details in the Information pane.



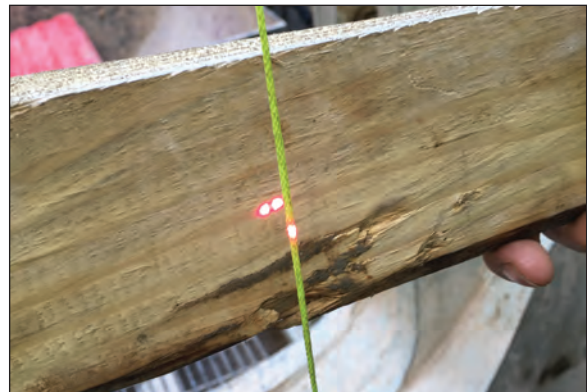
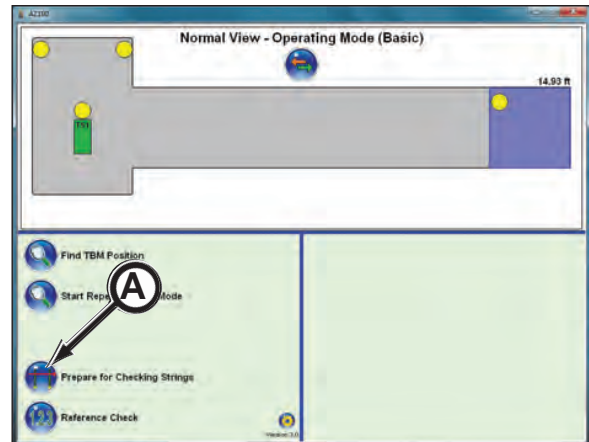
PREPARE FOR CHECKING STRINGS

With the survey string lines in place in the launch shaft, use the Prepare for Checking Strings button (A) to check the survey lines to the tunnel alignment. Once clicked, the shaft station will turn and rotate to set location and turn the laser light on.

Also, whenever there is a reference check error, click the Prepare for Checking Strings button as follows:

- If the laser light is aligned to the string lines, then a prism was bumped and the reference prisms positions need to be reset (retightened). Refer to Setting Reference Prism Positions in this section.
- If the laser light is not aligned to both string lines, then the shaft station was bumped. In this case the shaft station, prisms and pipe station(s) will all have to be realigned to the survey string lines. Refer to Align Tunnel to Plumb Lines in this section.

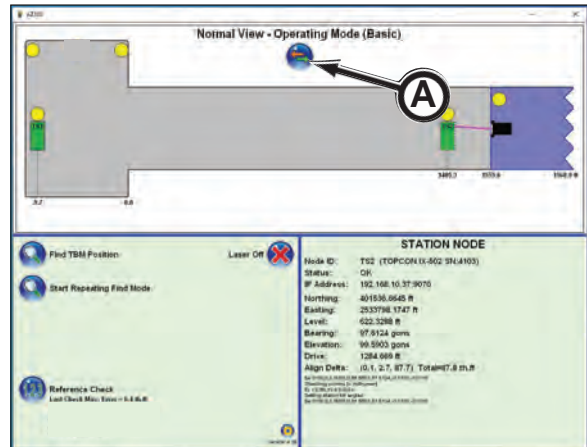
Once tunnel is aligned and the reference prisms are configured, click the Find TBM Position button on the Operating Mode screen, refer to Finding TBM Position in this section.



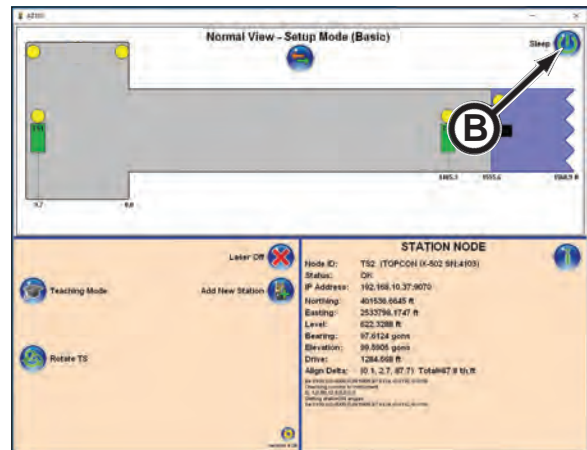
USING SLEEP MODE

BEFORE shutting down Head Power, typically while adding a new pipe and utilities, it is a good practice to place the total stations into Sleep Mode and is recommended when there are four or more total stations in the tunnel. Sleep mode allows the total stations to complete any background tasks before shutting off power to prevent data corruption.

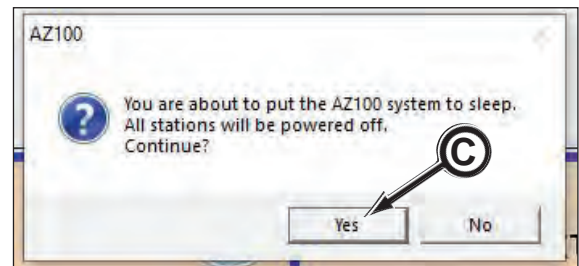
1. In Operating Mode, click switch button (A) to change view from Normal View - Operating Mode to Normal View - Setup Mode screen.



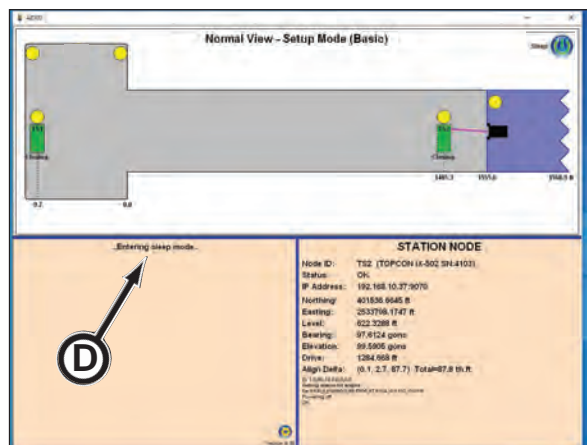
2. Click Sleep button (B).



3. The AZ100 Sleep confirmation window appears. Click Yes (C).

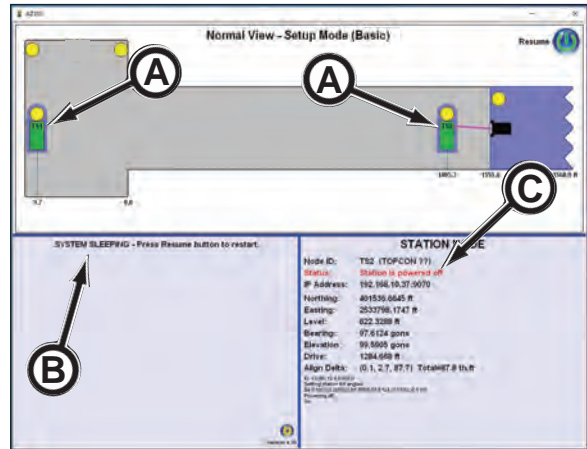


4. In the control pane, “..Entering sleep mode..” (D) appears. This may take several seconds.



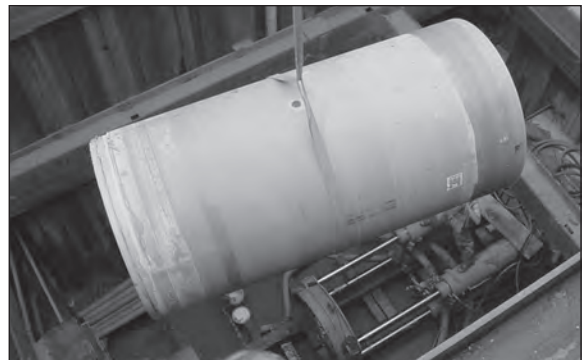
(continued on next page)

- Once complete, the System Sleeping screen will appear. The total stations will appear with a blue outline (A), the "System Sleeping - Press Resume button to restart" (B) will appear in the control pane and the status "Station is powered off" (C) will appear in the information pane.

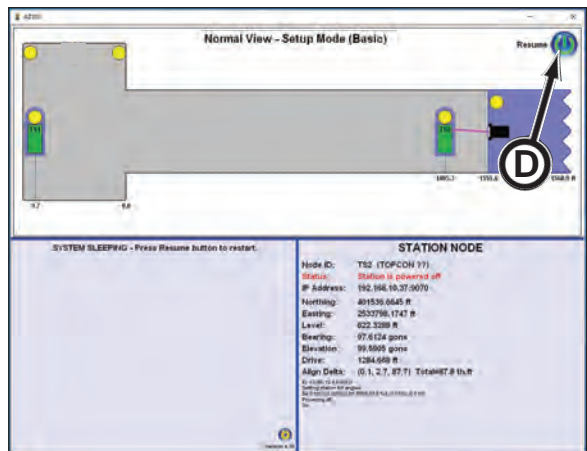


- With the AZ100 system in sleep mode, prepare to add new pipe and utilities by shutting down power and disconnecting utilities. For proper procedure, refer to your Microtunneling Operator's Manual, Adding New Pipe & Utilities in the Operation section.

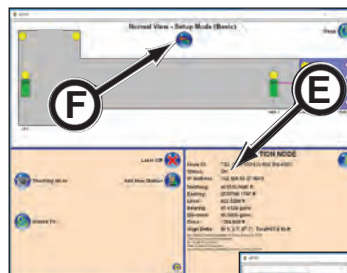
⚠ WARNING BEFORE reactivating power, be sure to communicate to all personnel that the electric and hydraulic power will resume shortly. Verification must be received from equipment operators that it is acceptable to restart. Failure to do so may cause serious injury or death from unintended equipment reactivation.



- When power has been restored after the new pipe set, click Resume button (D).



- Once the AZ100 system is back online the Normal View - Setup Mode window will appear with the Status OK (E).



- In Setup Mode, click switch button (F) to change view from Normal View - Setup Mode to Normal View - Operating Mode screen.



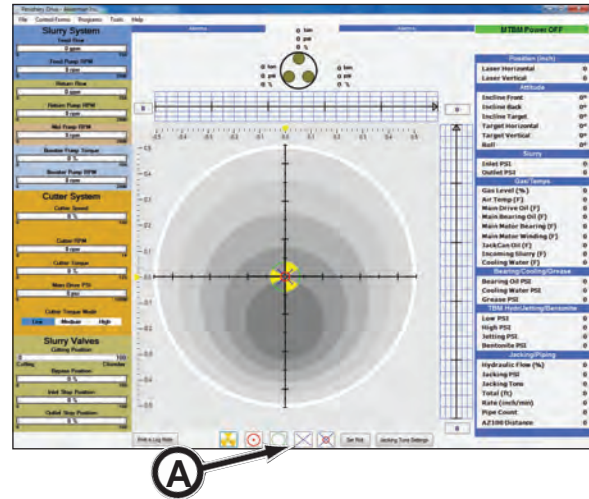
DAILY SHUT DOWN

If the total station(s) must be removed from the tunnel for security, moisture or other reasons, perform the following daily shut down procedures:

1. Before shutting down, record and mark (with laser position marker [A]) the laser positions on the microtunneling control target screen.
2. **BEFORE** removing total station from the launch shaft at the end of the day, the pipe must be completely pushed in, so it is possible to perform a Reference Check when the total station is reinstalled. Otherwise, the pipe and/or jacking frame may interfere with the visibility of the shaft station to the reference prisms.
3. With the power shut down, **CAREFULLY** remove total station(s) as necessary. The total stations must be kept as clean as possible and stored in the protective case in a climate controlled environment.

IMPORTANT: DO NOT move or bump the total station base, mounts or tribrach while removing total station. Doing so will require the tunnel to be completely realigned to the survey marks.

4. Remove the cables from the SNU and replace the bulkhead protective covers on the SNU ports. The SNU must be removed if there is a flood potential.
5. Collect the cables and place them in a safe location where they will not be damaged or subjected to moisture.



REINSTALLING TOTAL STATIONS IN TUNNEL

IMPORTANT: DO NOT move or bump the total station base, mounts or tribrach while reinstalling total station. Doing so will require the tunnel to be completely realigned to the survey marks.

Reinstall the total station(s) as follows:

1. If the SNU was removed, CAREFULLY reinstall and connect all cables to the SNU bulkhead connections and components.
2. CAREFULLY replace the total station to the tribrach. Secure with clamp and tribrach locking screw.
3. With all connections in place, power up the SNU.
4. Perform the tilt offset check on each total station. Refer to Checking Total Station Tilt Offset in this section.
5. Check the reference prism locations (refer to Performing Reference Check in this section).

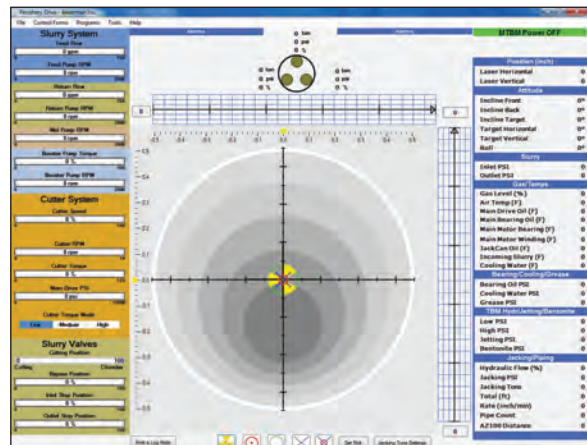
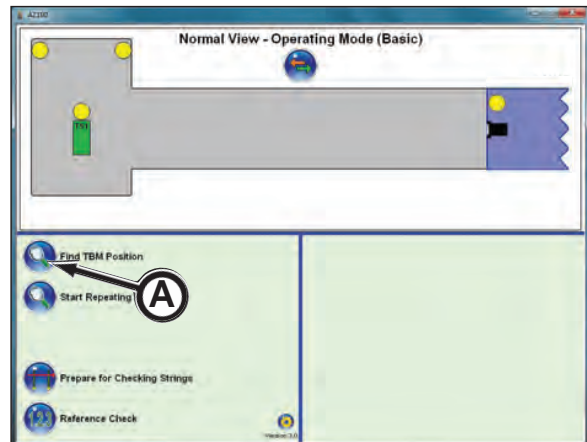
If the locations are correct, continue to step 6.

If locations are not correct, refer to Preparing for Checking Strings in this section.

6. The Find TBM Position (A) (refer to Finding TBM Position in this section) is required to place laser spot on target before starting.

NOTICE

BEFORE adding the pipe station online, record and mark the laser positions on the microtunneling control target screen. Once configured, check the recorded to current spot. If different, refer to Prepare For Checking Strings in this section.



NOTES

Periodic Maintenance

⚠ WARNING Review the Safety section in this manual and your tunneling equipment manual before performing maintenance. Failure to do so, could cause severe injury or death.

LOCKOUT TAGOUT POWER BEFORE SERVICING

⚠ WARNING Severe personal injury or death can result from unexpected power pack start-up or machine movement.

LOCKOUT TAGOUT power before attempting to make repairs or adjustments to this equipment, unless otherwise indicated. Proper lockout tagout will prevent accidents and save lives. Performing the lockout tagout will also prevent the equipment from moving or operating unexpectedly.



AVOID PINCH POINTS

⚠ WARNING Moving parts or the mishandling of parts can cause severe personal injury.

Keep hands away from moving parts.

Watch your fingers, hands, and legs while equipment is in operation.

Handle parts carefully to avoid crushing and pinch point hazards.



WELDING

UNAUTHORIZED WELDING

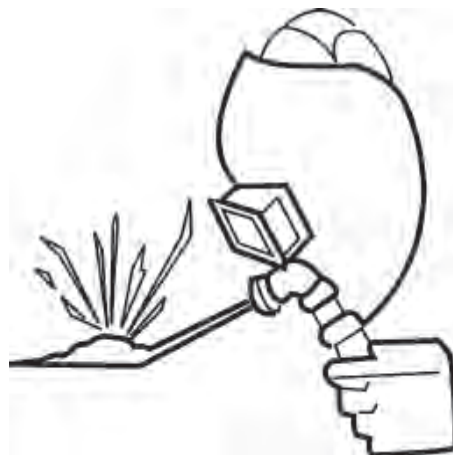
⚠ WARNING Unauthorized welding can cause structural failure and guidance system damage.

Do not weld on any structural member. Unauthorized welding or repair will void the warranty.

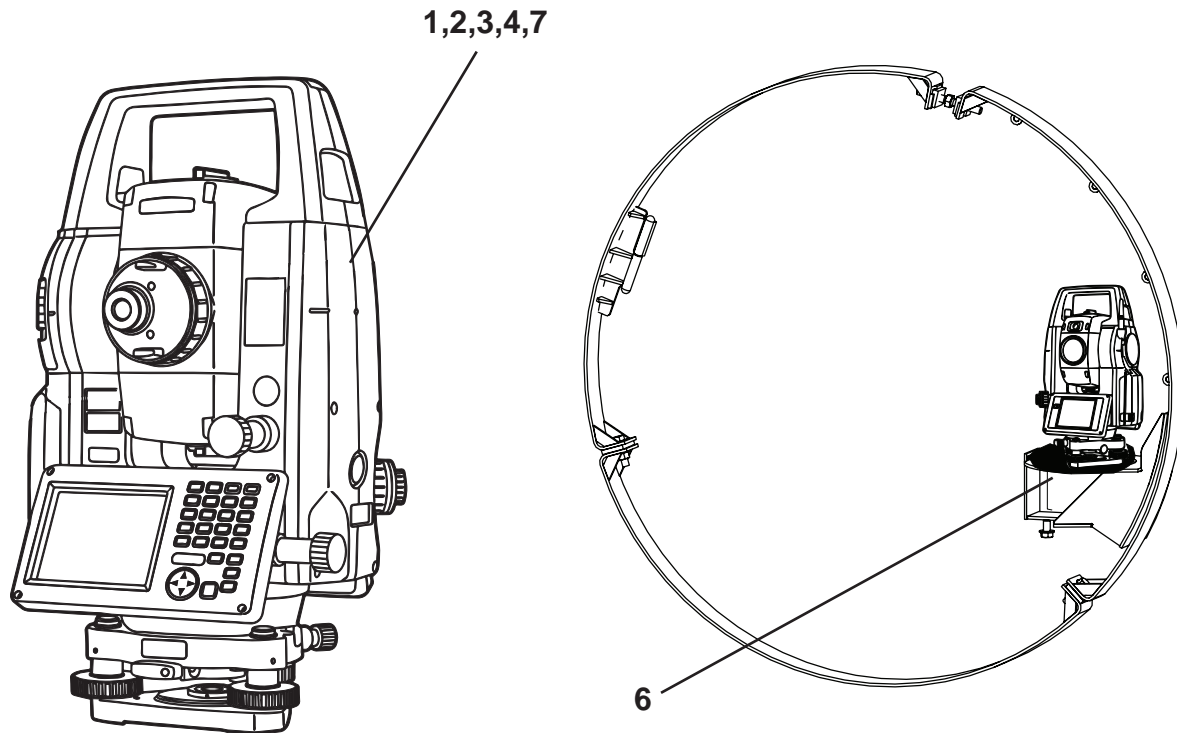
WELDING ON STRUCTURE

NOTICE Welding on structure will damage the total station and other guidance system components.

BEFORE performing authorized welding, remove the total station and guidance system components.



MAINTENANCE CHARTS



Total Stations shown without prism handle.

PRIOR TO JOB & WHENEVER SUBJECTED TO STRONG VIBRATION OR BUMPED

ITEM	COMPONENT	SERVICE	REFERENCE
1.	Total Station	Tilt Offset	Refer to Checking Tilt Offset in section 6, Operation.
2.	Total Station	Collimation	Refer to Checking Collimation in section 6, Operation.

DAILY OR EVERY 10 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REFERENCE
3.	Total Station	Tilt Offset	Refer to Checking Tilt Offset in section 6, Operation.
4.	Total Station	Inspect & Clean	Remove dirt/dust with clean soft cloth. Refer to TopCon.
5.	Cables/Plugs *	Inspect & Clean	Keep dry & clean. Repair or replace as needed.
6.	Self-Level Tribrach	Inspect & Clean	Remove dirt/dust with clean soft cloth.

* Not Shown

BEFORE LONG DRIVE OR AT LEAST EVERY TWELVE MONTHS

ITEM	COMPONENT	SERVICE	REFERENCE
7.	Total Station	Calibration	Contact TopCon &/or Akkerman Aftermarket Support rep.

Troubleshooting

AZ100 SOFTWARE

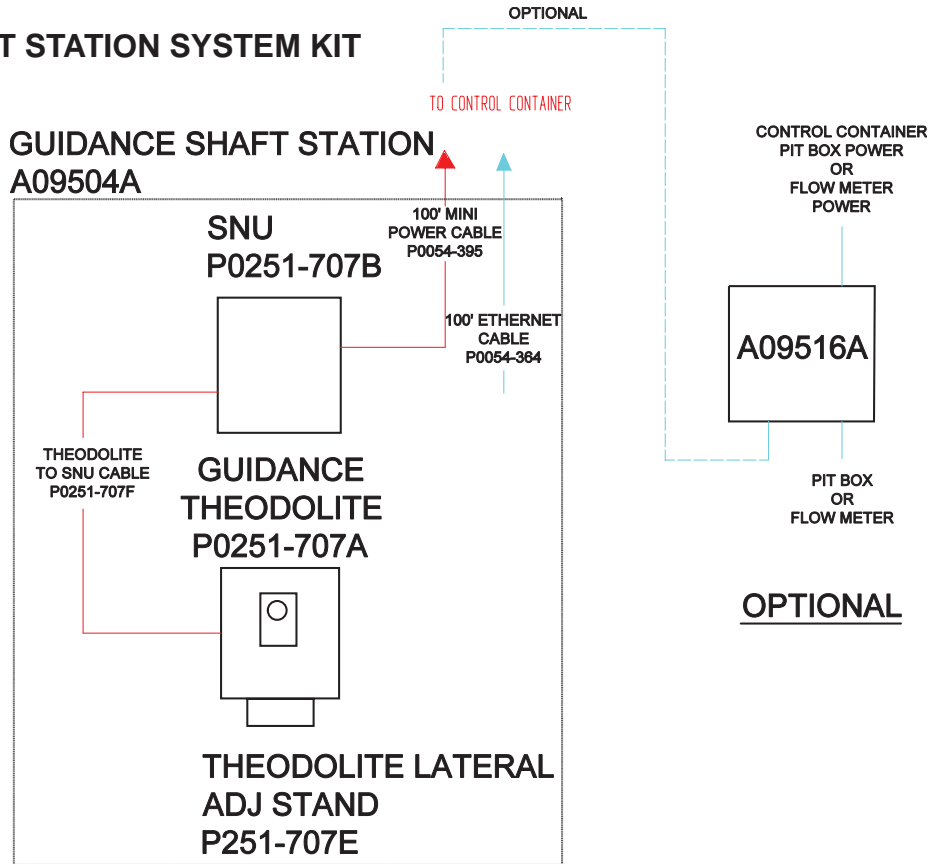
Problem	Cause	Solution
Shaft Station does not power up.	Power cable not installed from control container to SNU.	Connect power cable.
Pipe station does not power up.	Power cable not installed from front section box to SNU.	Connect power cable.
	Front section box is offline.	Power front section box.
Error: No prism found.	TBM prism not found.	Repeat Finding TBM Position. May require tunnel alignment.
	Reference prism not found.	Configure reference prisms.
Error: First set horizontal alignment using the plumb lines.	Align to Plumb Lines not performed before configuring the tunnel parameters.	Perform Align to Plumb Lines then configure the tunnel parameters.
Error: Position Out of Tolerance.	Reference prism or shaft station moved.	Perform Preparing for Checking Strings to determine if shaft station or a reference prism moved.
Tunnel distance measurement does not update.	Did not perform Find TBM Position.	Perform Find TBM Position after each dog to update the distance.
TS1 with red border status: Unable to establish connection.	Shaft station SNU power & comm cables not connected to total station or control container.	Connect SNU power & comm cables to total station and/or control container.
	Shaft station SNU power/comm (gray) cable is connected to the total station but the power (yellow) and/or comm (green) cables are not connected to the control container.	Connect power (yellow) and/or comm (green) cables to control container.
	Entered wrong IP address.	Enter correct IP address.
TS1 with red border status: Can PING but unable to establish connection.	Multiple AZ100 programs running.	In Task Manager, check for duplicate AZ100 programs running. If so, close (end task) all AZ100 programs and then reopen AZ100 program to verify only one program is running.
TS1 with orange border status: Connection established but no reply.	Shaft station SNU power (yellow) or comm (green) cables are connected to the control container but the power/comm (gray) cable is not connected tot the total station.	Connect power/comm (gray) cable to total station.

TOPCON® / SOKKIA® TOTAL STATION

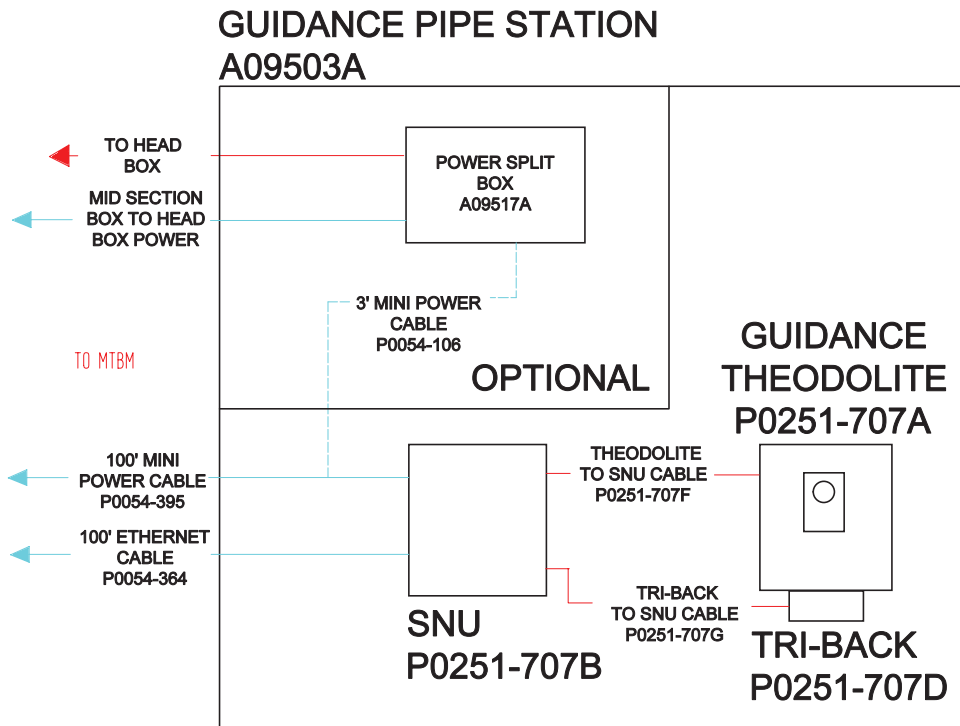
Error Message	Cause	Solution
Relevel error.	Total station bumped or other means to cause total station to be out of level.	Unplug total station from SNU. Re level total station then reconnect SNU to total station.
Bad condition.	The air quality is poor.	Ventilate tunnel and resight target.
Motor error EXXX	Motor drive problem.	Power OFF then ON. If frequent error, contact TopCon or total station manufacturer.
Temp Rnge OUT	Outside usable temp. range.	Repeat within appropriate temperature range.
Tilt over range !!	Tilt angle exceeds compensation range of the sensor.	Level the instrument again.
Time out !!	Measurement not carried out in allotted time.	Reset and sight the prism & perform measurement again.

GUIDANCE STATION KITS

SHAFT STATION SYSTEM KIT



PIPE STATION SYSTEM KIT



NOTES

Specifications

Guidance System Software Akkerman Proprietary

Self-Leveling Tribrach

Leveling Range in 2 Axes to ± 12 gon
Leveling Range in 1 Axis to ± 18 gon
Leveling Accuracy to ± 10 gon
Positive Centring Wild System
Power Supply 11 - 16 VDC/0.11 A
Carrying Capacity to 10 kg (22 lbs)
Weight 6.3 kg (13.89 lbs)

TopCon® Total Station (Total Station DS-101AC)

Telescope

Length 168 mm
Aperture 45 mm (1.8 in.) (EDM: 50 mm (2 in.)
Magnification 30X
Image Erect
Resolving Power 2.5"
Field of View 1°30' (26m/1,000m)
Minimum Focus 1.3 m (4.3 ft)
Focussing Screw 1 Speed
Reticle Illumination 5 Brightness Levels

Angle Measurement

Horizontal & Vertical Circles Type Rotary Absolute Encoder
Detecting 2 Sides
Angle Units Degree/Gon/Mil (selectable)
Minimum Display 0.5" (0.0001gon/0.002mil)/1"(0.0002gon/0.005mil) (selectable)
Accuracy 1" (0.0003gon/0.005mil)
Collimation Compensation On/Off (selectable)
Measuring Mode
Horizontal Angle Right/Left (selectable)
Vertical Angle Zenith/Horizontal/Horizontal $\pm 90^\circ$ /% (selectable)

Tilt Angle Compensation

Type Liquid 2-axis tilt sensor
Correction Unit 1"
Range of Compensation $\pm 6'$
Automatic Compensator ON (V & H/V)/OFF (selectable)
Tilt Offset Can be changed

Distance Measurement

Measuring Method Coaxial Phase-Contrast Measuring System
Signal Source Red Laser Diode 690nm

(continued on next page)

Sokkia® Total Station (Total Station iX series 502)

Telescope

Length 142 mm
 Aperture 38 mm (1.5 in.) (EDM: 38 mm (1.5 in.)
 Magnification 30X
 Image Erect
 Resolving Power 2.5"
 Field of View 1°30' (26m/1,000m)
 Minimum Focus 1.3 m (4.3 ft)
 Focussing Screw 1 Speed
 Reticle Illumination 5 Brightness Levels

Angle Measurement

Horizontal & Vertical Circles Type Rotary Absolute Encoder
 Detecting 2 Sides
 Angle Units Degree/Gon/Mil (selectable)
 Minimum Display 0.5" (0.0001gon/0.002mil)/1"(0.0002gon/0.005mil) (selectable)
 Accuracy 2" (0.0006gon/0.010mil)
 Collimation Compensation On/Off (selectable)
 Measuring Mode
 Horizontal Angle Right/Left (selectable)
 Vertical Angle Zenith/Horizontal/Horizontal ±90° /% (selectable)

Tilt Angle Compensation

Type Liquid 2-axis tilt sensor
 Correction Unit 1"
 Range of Compensation ±6'
 Automatic Compensator ON (V & H/V)/OFF (selectable)
 Tilt Offset Can be changed

Distance Measurement

Measuring Method Coaxial Phase-Contrast Measuring System
 Signal Source Red Laser Diode 690 nm

Warranty

Akkerman warrants that all equipment manufactured by it be free from defects due to workmanship or material when normally used and serviced for a period of 90 days from the date of shipment by Akkerman. Normal wear and tear to the equipment, including, but not limited to, wear on the cutter face tooling, hydraulic filters, augers, casings, slurry line and seals is not covered by this warranty. Akkerman does not warrant that the equipment meets the requirements of any particular safety code or rule governing equipment classification. If the Customer has questions about local safety codes, rules or ordinances, authorities local to the project should be consulted.

In order to be considered as a potential warranty claim, the component in question must be returned to Akkerman (freight prepaid) for factory inspection and analysis, and determination of warranty applicability. No warranty is provided for electronics or electrical components of any kind. The validity of all warranty claims are subject to the discretion and determination of the Akkerman Aftermarket Support Department. All such determinations are final.

Warranty

NOTES

Index

A

Active laser 5-21, 5-30
Add new station 5-30
Align..... 5-26
Align to plumb lines 5-25
Align tunnel to plumb lines..... 5-22, 5-34, 5-41
Aligning the tunnel to current station 5-23, 5-34
Alignment data..... 5-32
All lasers on 5-22, 5-34
Az100 basic 5-19
Az100 settings 5-19, 5-39
Az100 software.....i, 4-1
Az100 software screens terminology..... 3-4
Az100 software troubleshooting 7-1

B

Be alert for safety information 1-1
Before long drive maintenance..... 6-2
Beware of suspended loads 1-4

C

Charts, maintenance 6-2
Check, tilt offset 5-12
Checking collimation..... 5-17
Checking total station tilt offset..... 5-45
Collimation..... 5-17, 5-18
Collimation, checking..... 5-17
Collimation/result..... 5-18
Config 5-13, 5-17, 5-26
Configure tbm parameters..... 5-25
Configure total station - ts1..... 5-21
Configure total station - ts2..... 5-30
Configure ts1 5-21
Configure ts2 5-30
Configure ts3 5-30
Configure tunnel parameters 5-24
Contents iii
Control pane 5-19
Controls & instruments 4-1
Coordinates, ts1 5-21
Crushing hazard 1-4
Curve tunnels 5-32

D

Daily or every 10 hours maintenance 6-2
Daily shut down 5-44
Decals, pipe station safety..... 2-2
Decals, safety 2-1
Decals, total station safety..... 2-1
Distance measurement..... 5-26, 5-38
Dongle 5-19

E

Electronic bubble..... 5-9
Error - no prism found..... 5-27, 5-28, 5-37
Error - position out of tolerance 5-30, 5-40

E (continued)

Esc..... 5-12, 5-17
Ethernet repeater box 3-6
Every six months maintenance..... 6-2
Expandable pipe band 5-11

F

Find tbm position
..... 5-26, 5-29, 5-31, 5-34, 5-38, 5-39, 5-41
Find tbm position - pipe station..... 5-38
Find tbm position - shaft station..... 5-38
Finding prism position 5-6
Fire prevention..... 1-5
First set horizontal alignment..... 5-25

G

Guidance station kits 7-3

H

Head power 5-32, 5-42
Horizontal deviation i, 5-2
Hydraulic power under pressure 1-2

I

Information button..... 5-23, 5-25
Information pane..... 5-19, 5-28, 5-30
Inst.Cons 5-14, 5-17
Instruments & controls 4-1
Introduction..... i

J

Job parameters, reset..... 5-33
Job site clean..... 1-6

L

Laser exposure..... 1-2, 5-22, 5-34
Laser light..... 5-22, 5-34
Last check max. Error..... 5-29, 5-40
Launch shaft..... 5-4
Line of sight, prisms 5-6
Lockout tagout power 1-2, 1-3, 6-1

M

Maintenance charts 6-2
Maintenance, before long drive 6-2
Maintenance, daily or every 10 hours..... 6-2
Maintenance, every six months 6-2
Maintenance, periodic 6-1
Maintenance, prior to job 6-2
Manufacturer 5-21, 5-30
MEAS 5-8
Modify alignment window 5-24
Mount, pipe station 5-11
Mount, shaft station 5-4
Moving parts, keep away..... 1-4
Mtbm length..... 5-25

N

Name 5-24
 New vertical alignment set..... 5-24
 Normal mode 5-23
 Normal view - operating mode screen..... 3-4
 Normal view - setup mode screens 3-4

O

Operating guidelines..... 5-1
 Operating mode screens 3-4
 Operation..... 5-1
 Operation in progress 46
 Operator's manual, read 1-1
 Overview..... 5-2

P

Parameters, reset job 5-33
 Performing reference checks..... 5-40
 Periodic maintenance 6-1
 Pinch points 1-5, 6-1
 Pipe station..... 2-2, 4-1
 Pipe station..... 5-30
 Pipe station icon 5-31
 Pipe station safety decals 2-2
 Pipe station system kit..... 7-3
 Pipe station telescope 5-30
 Pipe station terminology 3-3
 Pipe station, assembling..... 5-11
 Pipeline..... 5-29, 5-31, 5-38
 Pitch..... 5-32
 Plumb bob, using..... 1-4
 Plumb bobs..... 1-4, 5-10, 5-34, 5-22
 Power split box 3-5, 4-3, 5-11
 Power split box, terminology..... 3-5
 Practice safe maintenance 1-3
 Preparing for checking strings
 5-29, 5-40, 5-41, 5-45
 Prior to job maintenance..... 6-2
 Prism 5-3, 5-26
 Prism drive offset..... 5-25
 Prism guidelines, shaft 5-3
 Prism position 5-6
 Prism vertical offset 5-21, 5-30
 Protective clothing 1-1

R

Radiation 5-22, 5-34
 Read operator's manual 1-1
 Recycle waste 1-6
 Reference check..... 5-29, 5-45
 Reference check error 5-29, 5-41
 Reference checks..... 5-40
 Reference prism 5-6, 5-27, 5-40
 Reference prism positions 5-36, 5-41
 Reinstalling total stations in tunnel 5-45
 Repeat mode icon 5-39
 Repeated hit interval 5-39
 Reset, configure total station 5-30

R (continued)

Reset job parameters 5-20, 5-33
 Resume button 5-43

S

Safe maintenance, practice 1-3
 Safety 1-1
 Safety decals 2-1
 Safety information..... 1-1
 Searching 5-26
 Set alignment..... 5-24
 Setting reference prism positions .. 5-34, 5-36, 5-41
 Setup mode screens 3-4
 Shaft distance..... 5-24
 Shaft prism 5-3, 5-40
 Shaft station..... 4-1
 Shaft station system kit..... 7-3
 Shaft station terminology 3-1, 3-2
 Shaft station, assembling 5-4
 Shaft station, preparing 5-9
 Shut down, daily 5-44
 Slippery when wet 1-5
 Smoking, no..... 1-6
 SNU 5-11, 5-44, 5-45
 SNU ip address 5-21, 5-30
 Software, az100..... 4-1
 Start repeating find mode 5-39
 Station height..... 5-24
 Station is powered off 5-43
 Station network unit..... 4-2
 Station node status..... 5-21, 5-31
 Status ok 5-43
 Steady state 5-11
 Stop repeating button 5-39
 String line..... 5-34, 5-41
 Survey lines 5-41
 Surveying marks..... 5-10, 5-22, 5-34
 Suspended loads 1-4
 System setup..... 5-19
 System sleeping 5-43

T

Target not found 5-7
 TBM data 5-32
 Tbm name 5-25
 Tbm prism..... 5-38
 Teach prism position..... 5-27, 5-36
 Teaching mode button 5-21, 5-26, 5-36
 Teaching mode screens..... 3-4
 Terminology 3-1
 Terminology, az100 software screens 3-4
 Terminology, pipe station 3-3
 Terminology, power split box 3-5
 Terminology, shaft station 3-1, 3-2
 Test shaft 1-3
 Test tunnel ventilation 1-3
 Tilt offset 5-12, 5-15
 Tilt offset/obs 5-15

Index

T (continued)

Tilt offset compensation..... 5-19
Tlt_ofs..... 5-13
Total station 4-2
Total station safety decals 2-1
Total station tilt offset..... 5-12
Total station troubleshooting..... 7-2
Total stations in tunnel..... 5-45
Tribrach 5-9, 5-11, 5-12
Tribrach, level..... 5-12
Troubleshooting..... 7-1
Troubleshooting, az100 software 7-1
Troubleshooting, total station 7-1
TS1 icon 5-21
TS2 icon 5-31
Tunnel alignment..... 5-24, 5-33, 5-38
Tunnel alignment mode 5-26
Tunnel bearing..... 5-24
Tunnel diameter..... 5-24
Tunnel grade 5-24
Tunnel length..... 5-24
Tunnel portal..... 5-26
Tunnel ventilation, test..... 1-3
Tunnel view pane 5-19
Tunnel view 5-39
Turning 5-26

U

Unauthorized, welding..... 1-4, 6-1

V

Vertical deviation i, 5-2

W

Waiting..... 5-26
Warranty 1-1, 9-1
Waste, recycle..... 1-6
Welding, unauthorized..... 1-4, 6-1

Y

Yaw..... 5-32

NOTES