



**OPERATOR'S
MANUAL
AZ100 TGS
Total Guidance System
Application Mode: Curve
Publication No. 050147A**

Rev. No. 190913 R220929

© Akkerman Inc. 2019, 2022
All Rights Reserved

Akkerman Inc. 58256 266th Street Brownsdale, MN 55918
Phone: 507-567-2261 Fax: 507-567-2605 email: akk@akkerman.com

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.

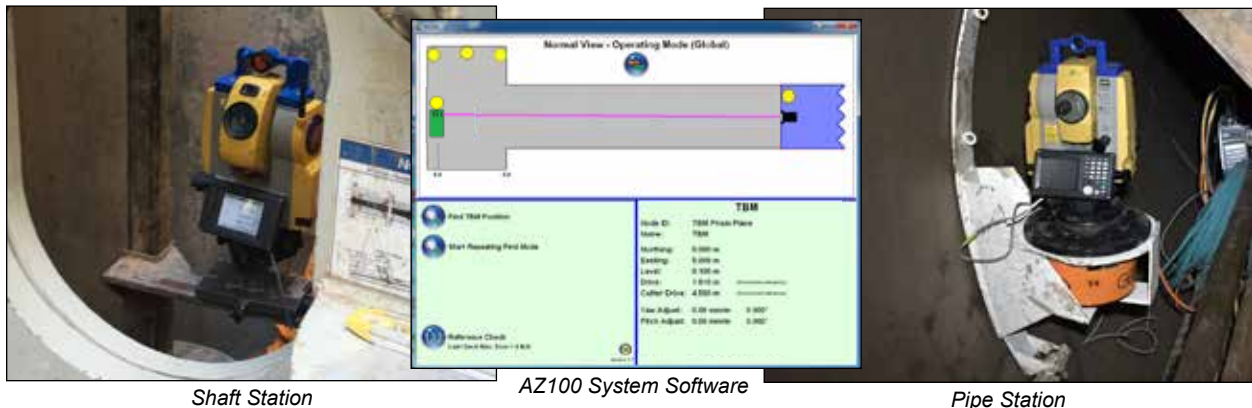
⚠ DANGER Indicates an extremely hazardous situation which, if not avoided, WILL result in death or serious injury.

⚠ 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. Pipe stations are added as required along the curved tunnel 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 (300-1,000m) dependent upon prism size, tunnel diameter, curve radius 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	5-10
Practice Safe Maintenance	1-3	Checking Total Station Tilt Offset	5-11
Beware Of Suspended Loads	1-4	Checking Collimation	5-16
Keep Personnel Away From Moving Parts	1-4	Loading Drive DTA (Designed Tunnel Axis) ..	5-18
Unauthorized Welding	1-4	System Setup Using AZ100 Software Program ..	5-20
Avoid Pinch Points	1-5	Reset Job Parameters	5-33
Fire Prevention	1-5	Finding TBM Position	5-34
Slippery When Wet	1-5	Start Repeating Find Mode	5-35
Keep Job Site Clean & Organized	1-6	Performing Reference Checks	5-36
No Smoking In Tunnel	1-6	Auto Prism Alignment	5-37
Recycle Waste	1-6	Using Sleep Mode	5-42
Safety Decals	2	Daily Shut Down	5-44
Total Station	2-1	Reinstalling Total Stations In Tunnel	5-45
Pipe Station	2-2	Periodic Maintenance	6
Terminology	3	Lockout Tagout Power Before Servicing	6-1
TOPCON Total Station Theodolite/Shaft Station ..	3-1	Avoid Pinch Points	6-1
SOKKIA Total Station Theodolite/Shaft Station ...	3-2	Welding	6-1
Pipe Station	3-3	Maintenance Charts	6-2
AZ100 Software Screens	3-4	Troubleshooting	7
Power Split Box	3-5	AZ100 Software	7-1
Ethernet Repeater Box	3-6	TopCon®/Sokkia® Total Station	7-2
Controls & Instruments	4	Guidance Station Kits	7-3
AZ100 Software	4-1	Specifications	8
Shaft Station	4-1	Warranty	9
Pipe Station	4-1	Index	10
Total Station	4-2		
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.



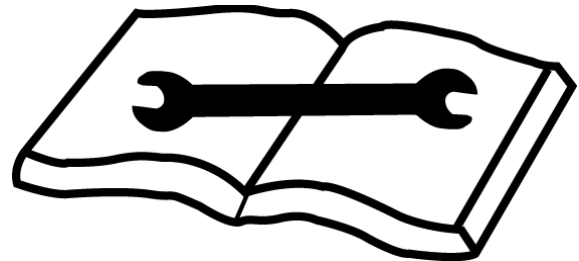
**ATTENTION!
BECOME ALERT!
YOUR SAFETY IS INVOLVED!**

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.

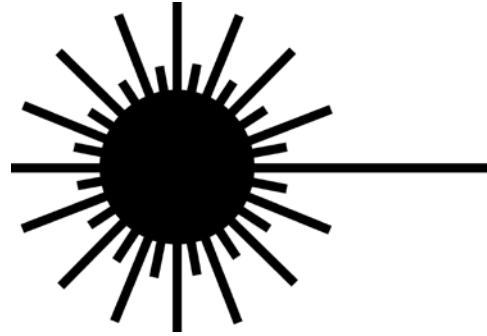


AVOID LASER LIGHT EXPOSURE

⚠ 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.

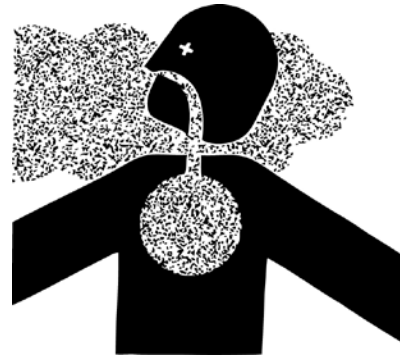
Use an approved air analyzer to detect hazardous gases and oxygen content.

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.



BEWARE OF SUSPENDED LOADS

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

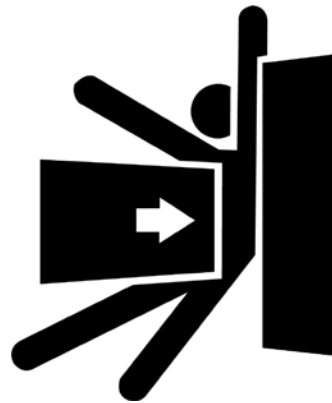
If a hydraulic hose breaks from the boom of a crane/excavator, or the lifting support fails, the boom and/or load can fall instantly.

Do not enter area under or around a suspended load.



KEEP PERSONNEL AWAY FROM MOVING PARTS

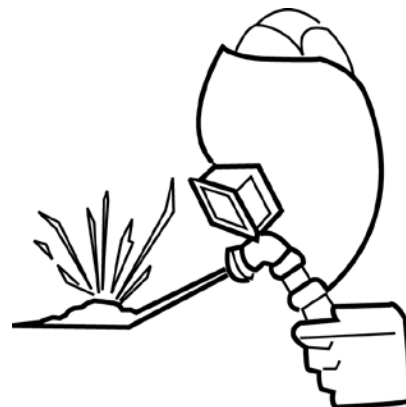
⚠ WARNING Crushing hazard.
Keep personnel away from inside of jacking frame.
Failure to do so could result in serious personal injury or death.



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.



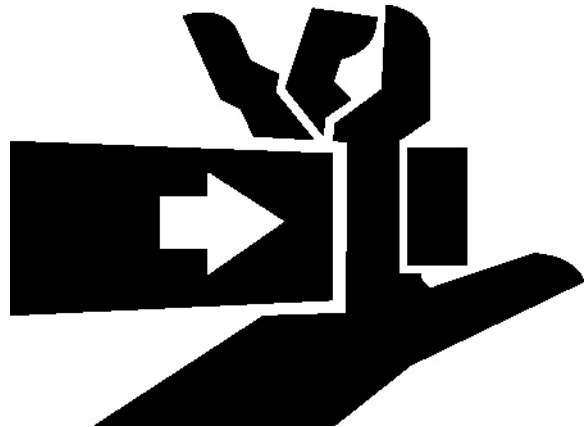
AVOID PINCH POINTS

⚠ 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.

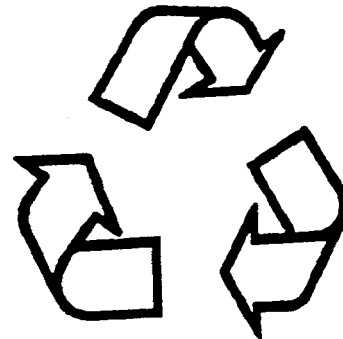
Do not smoke in tunnel.



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.



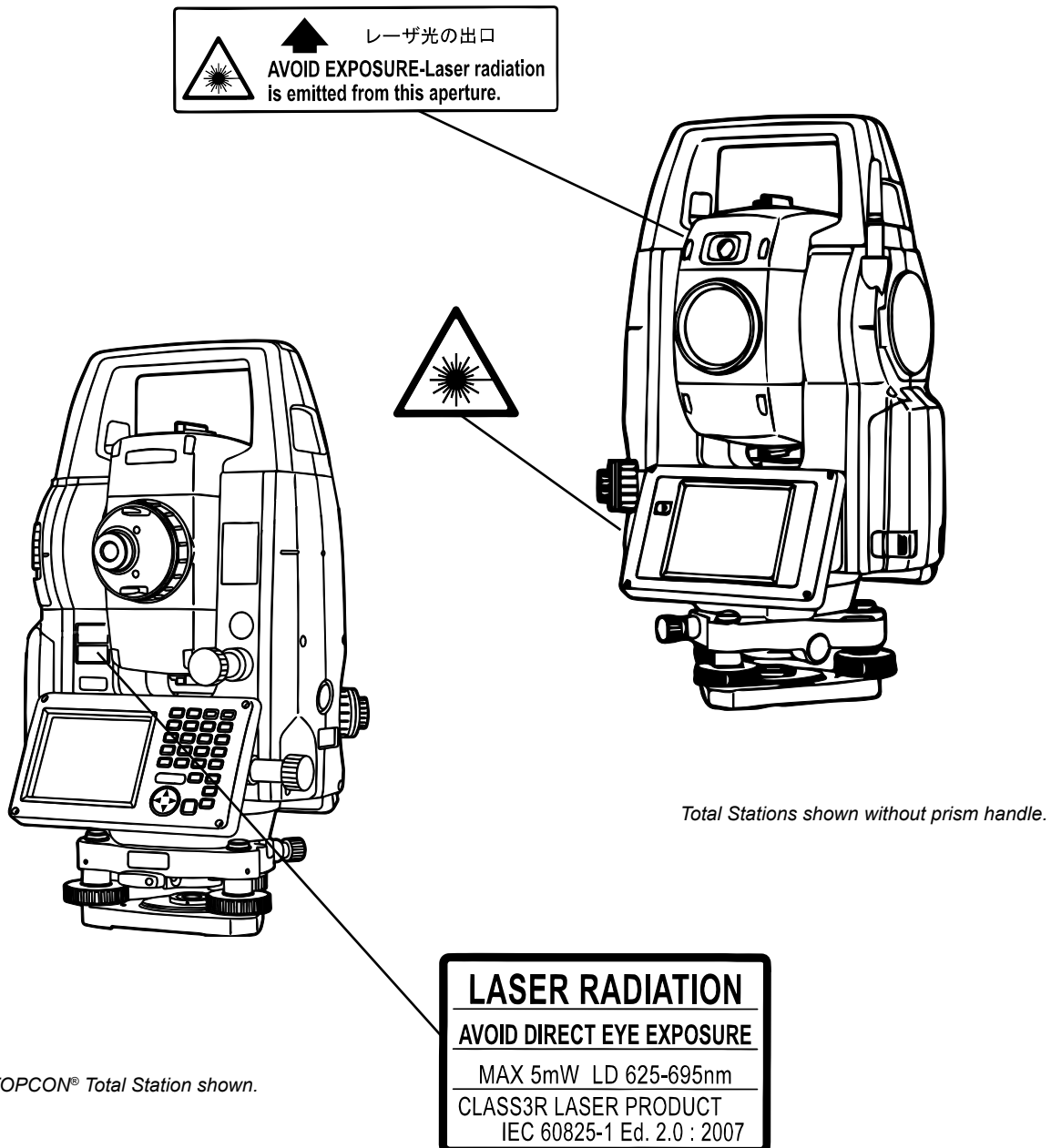
Safety Decals

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.

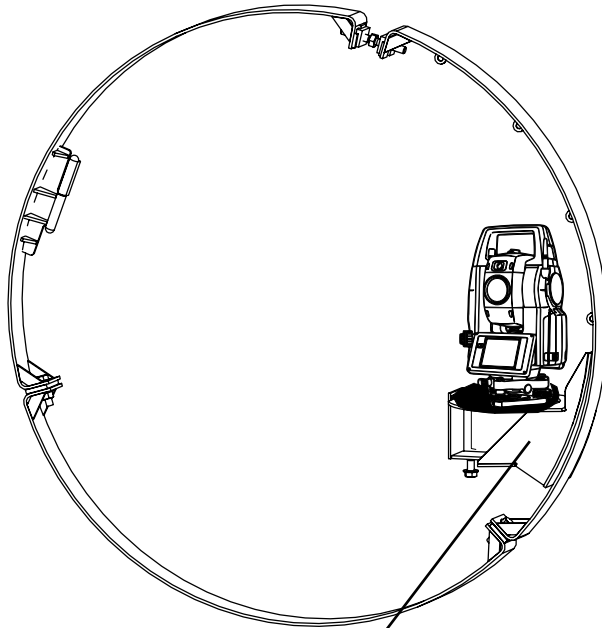
Serious injury or property damage can occur if safety instructions are not followed. Contact your Akkerman Aftermarket Support representative for free replacement safety decals.

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.

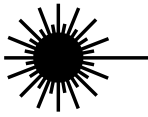
TOPCON® / SOKKIA® TOTAL STATION



PIPE STATION



Total Station shown without prism handle.

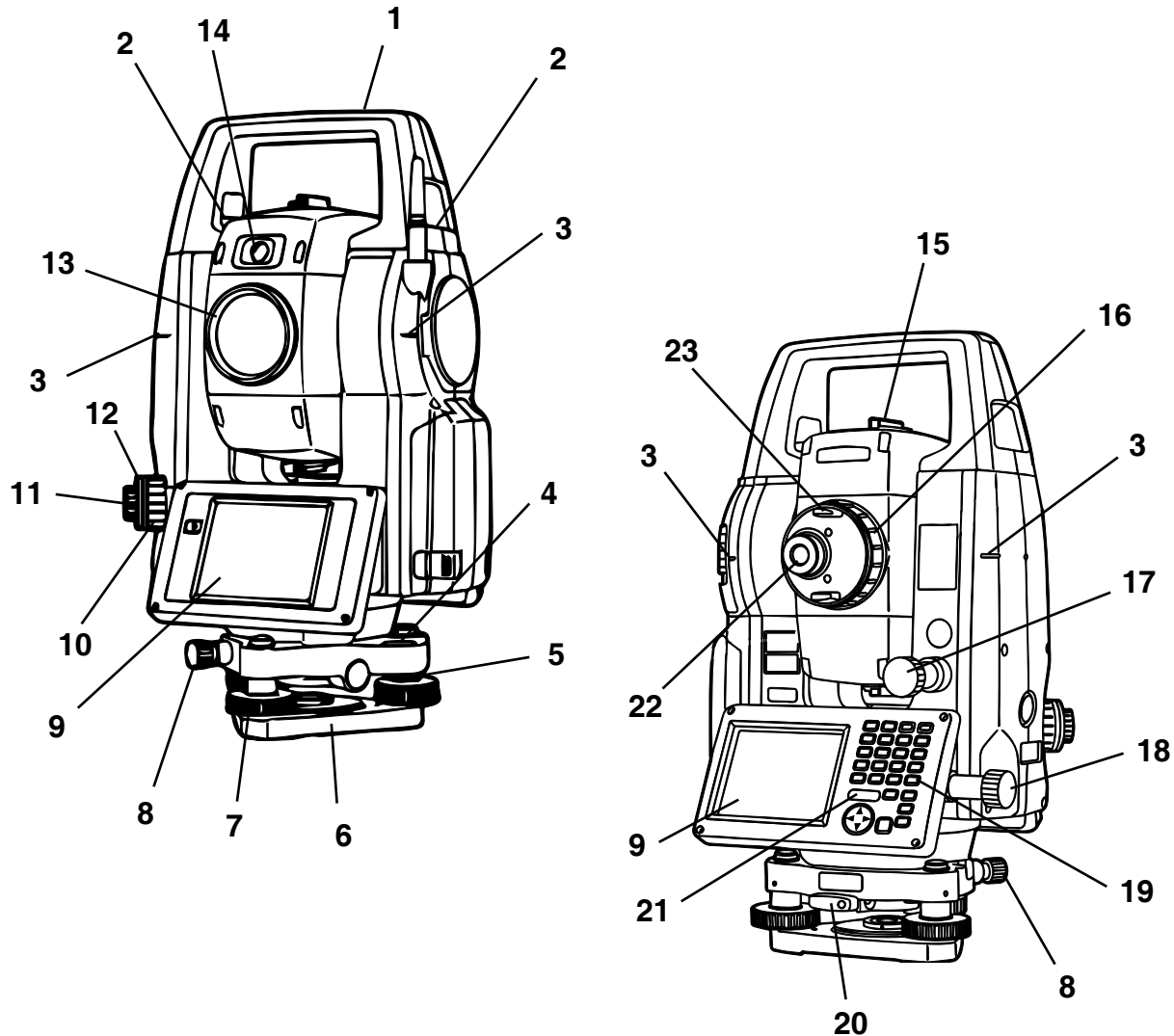
	<p>⚠ DANGER</p> <p>Staring into laser light will cause severe injury.</p> <p>Do not stare into laser guidance system light beam. Avoid direct eye exposure.</p> <p><small>022419 0001</small></p>
---	--

Terminology

TOPCON® TOTAL STATION THEODOLITE - SHAFT STATION

NOTICE

For more information, refer to your theodolite instruction manual.



Total Stations shown without prism handle.

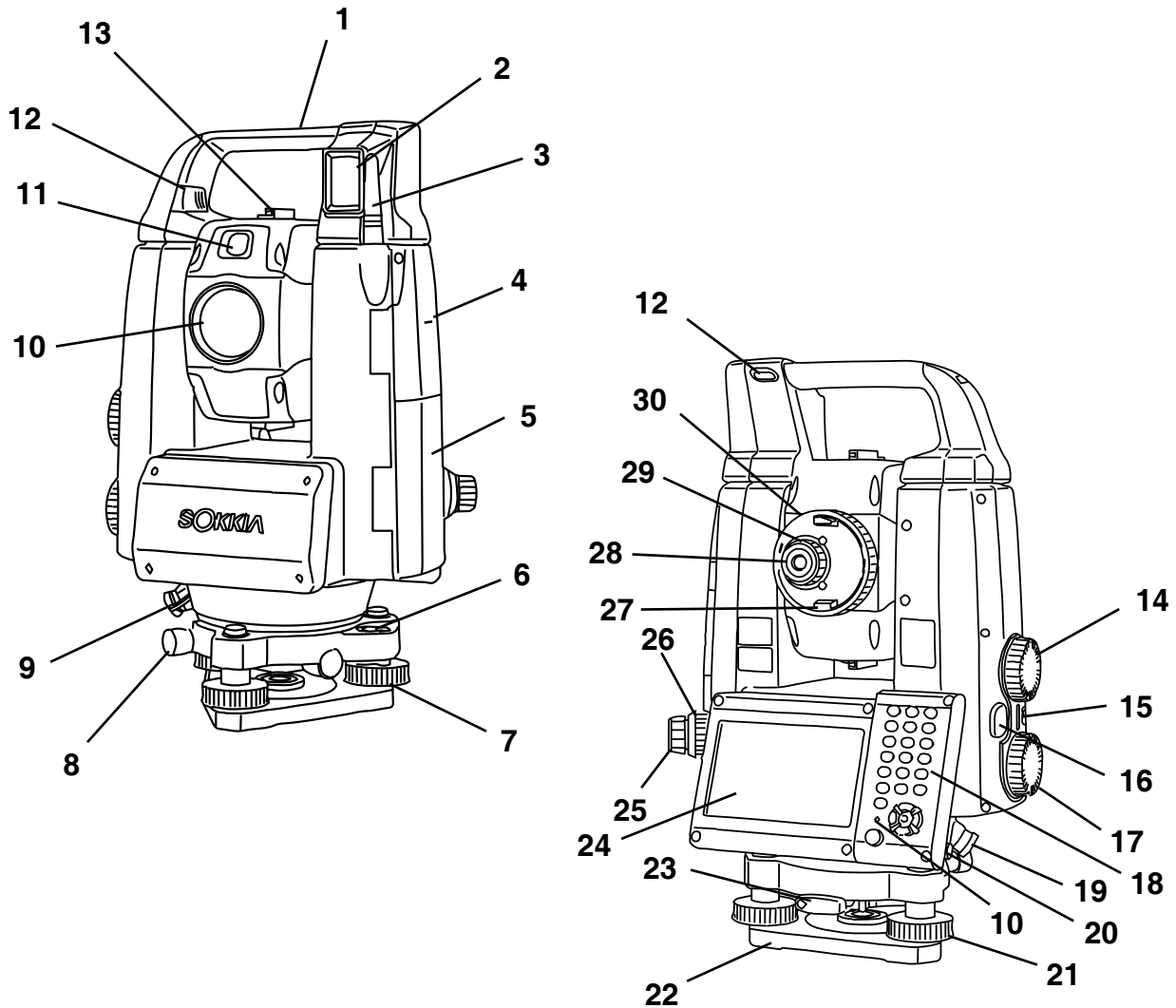
- | | | |
|------------------------------------|-----------------------------------|------------------------|
| 1. Handle (shown without prism) | 9. Display Unit | 17. Vertical Jog |
| 2. Handle Locking Screw | 10. Optical Plummet Focusing Ring | 18. Horizontal Jog |
| 3. Instrument Height Mark | 11. 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 | |

TOPCON® are registered trademarks of Topcon Positioning Systems, Inc.

SOKKIA® TOTAL STATION THEODOLITE - SHAFT STATION

NOTICE

For more information, refer to your theodolite instruction manual.

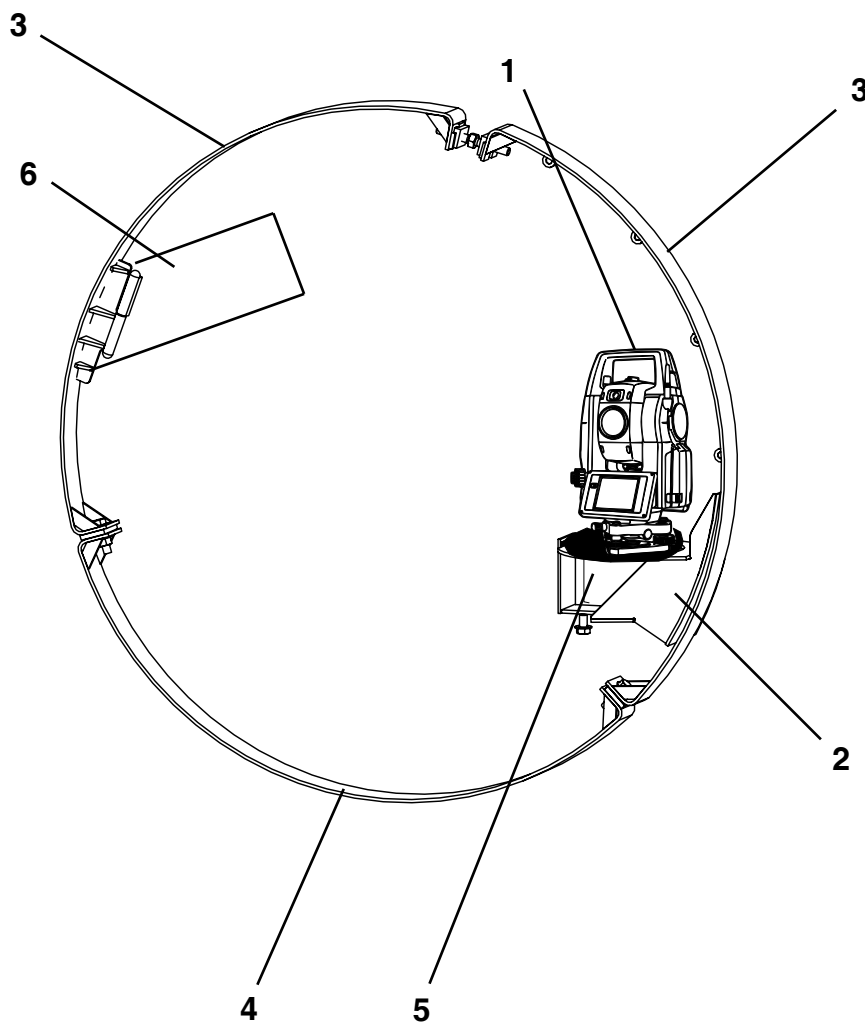


Total Stations shown without prism handle.

- | | | |
|------------------------------------|-------------------------------------|-----------------------------------|
| 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 |

SOKKIA® are registered trademarks of Topcon Positioning Systems, Inc.

PIPE STATION



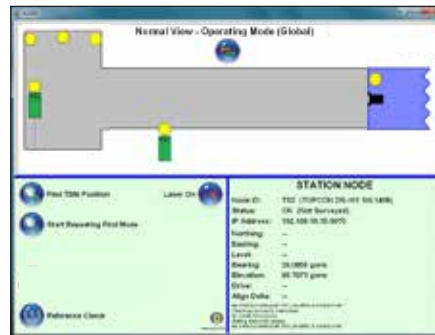
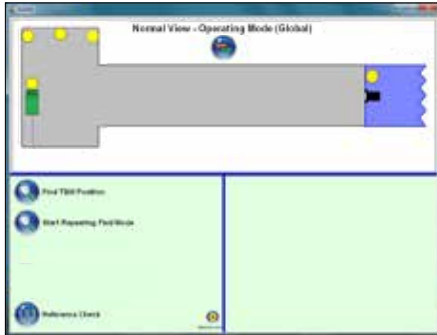
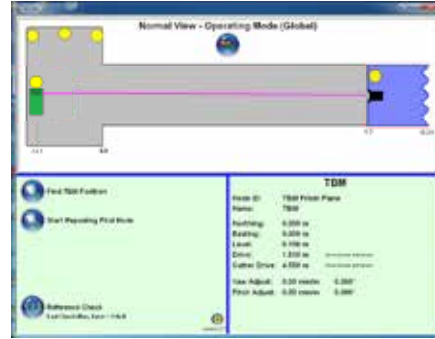
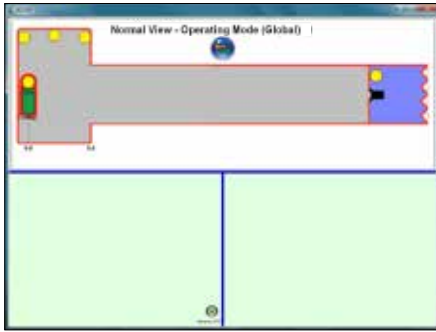
Total Station shown without prism handle.

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

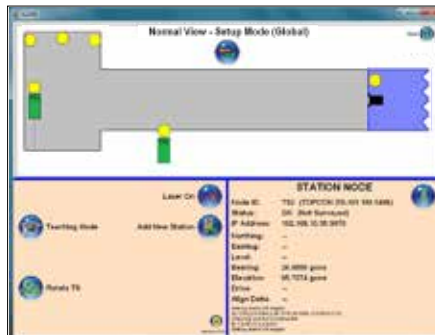
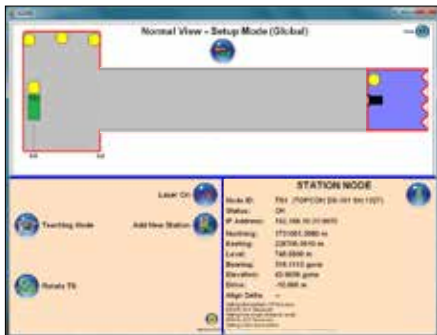
NOTE: SNU is not shown.

AZ100 SOFTWARE SCREENS

• Normal View - Operating Mode

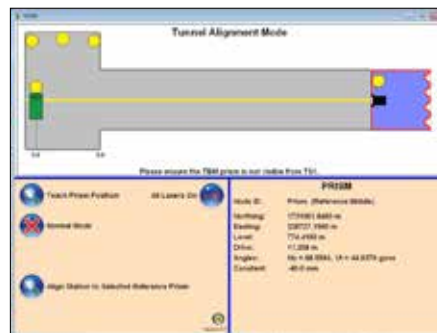
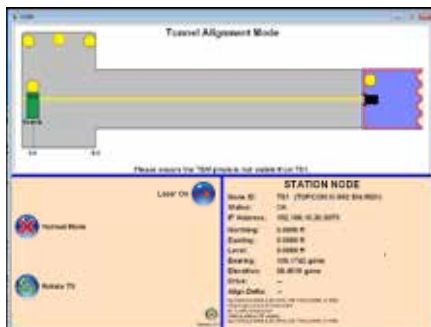


• Normal View - Setup Mode

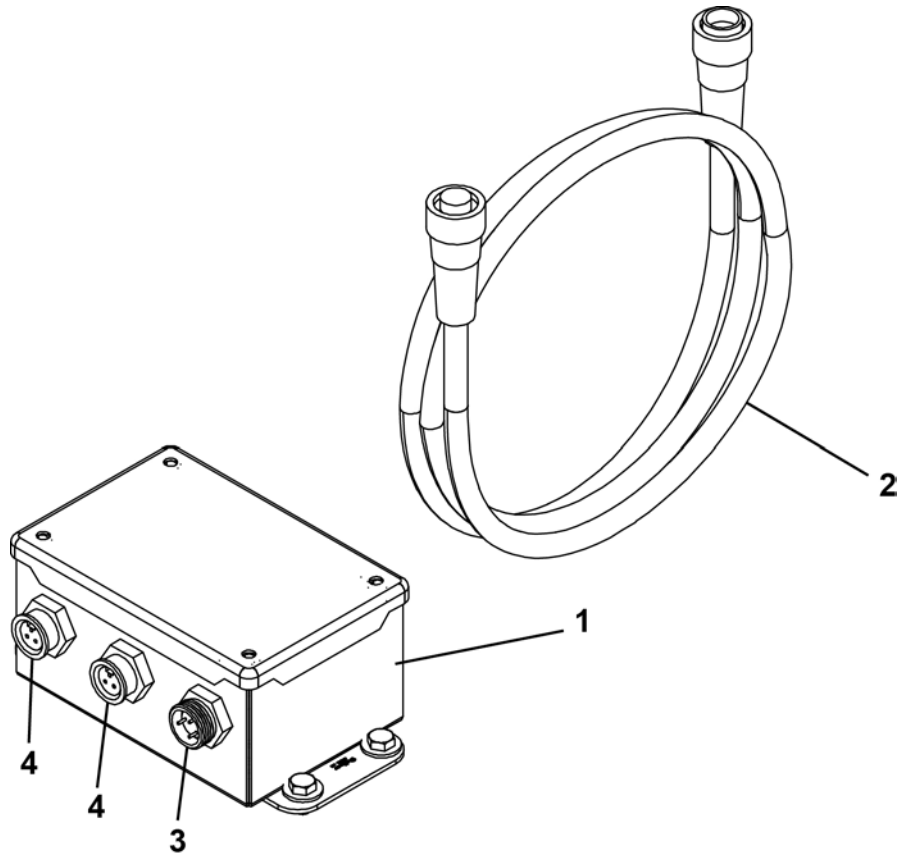


Sleep Mode

• Tunnel Alignment Mode

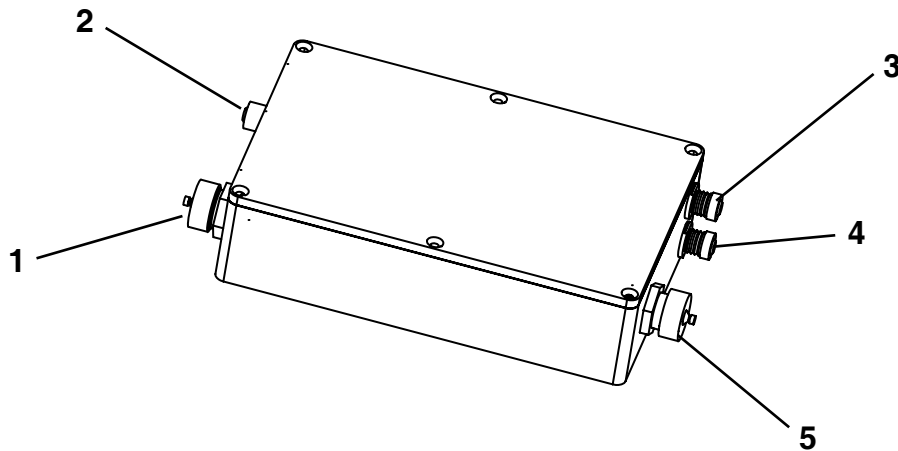


POWER SPLIT BOX



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.

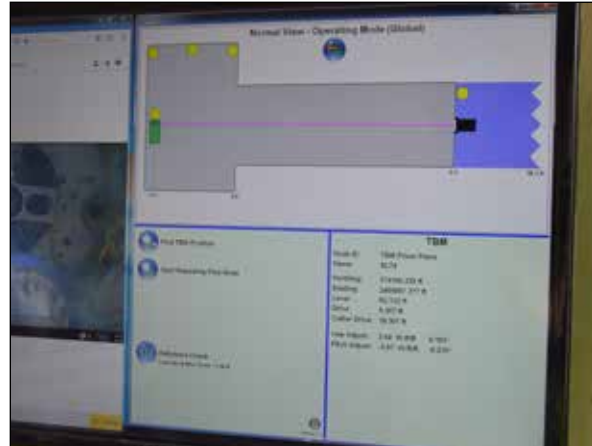
Typically a SNU is installed per pipe station but can be used independently as an ethernet repeater if there is an extra one on the job site.

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.

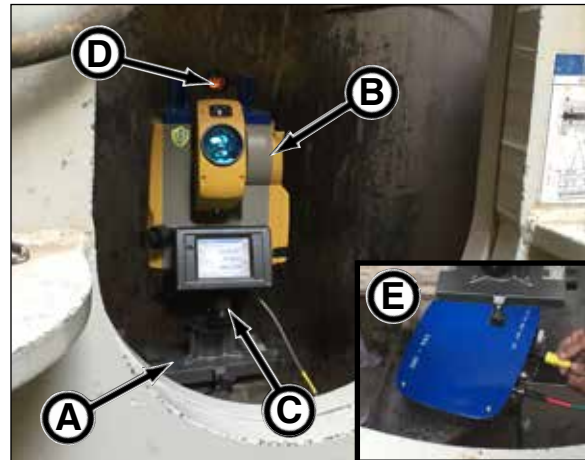
This system can be used for extended and curved tunneling in pipe jacking and microtunneling applications regardless of equipment manufacturer.



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.



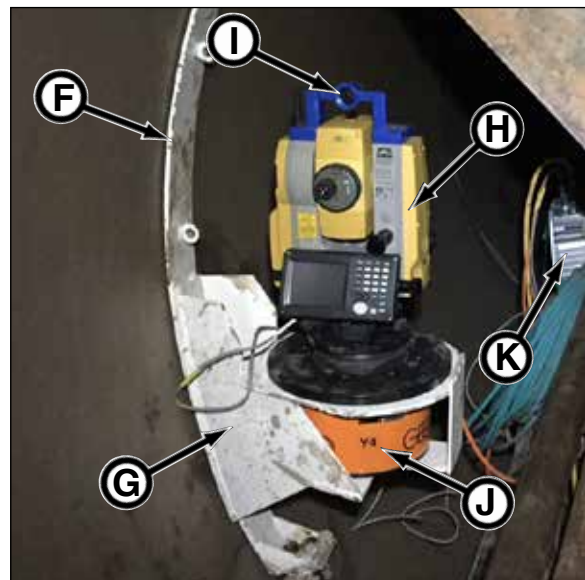
PIPE STATION

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.



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.

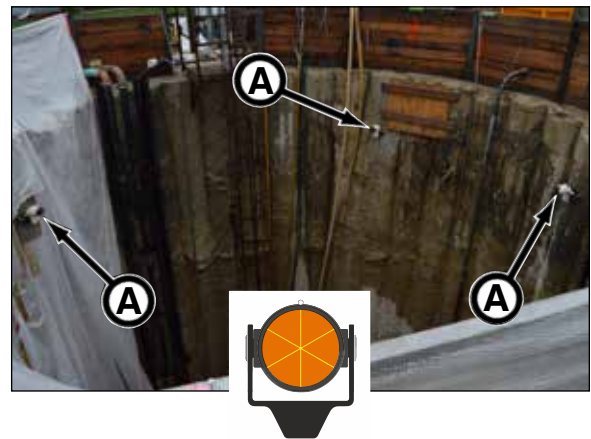


REFERENCE PRISMS

With a curved tunnel, there are three reference prisms (A).

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

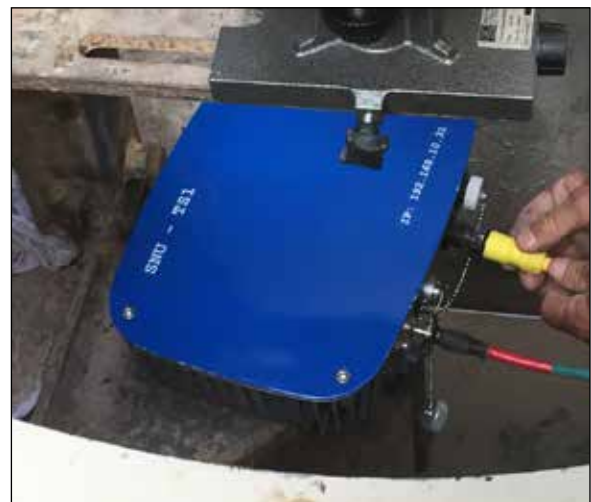
The total station will perform a reference check based on the location of the prisms for errors. If errors occur, it may indicate a prism or prisms are not in the original position or possibly the shaft station was bumped.



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

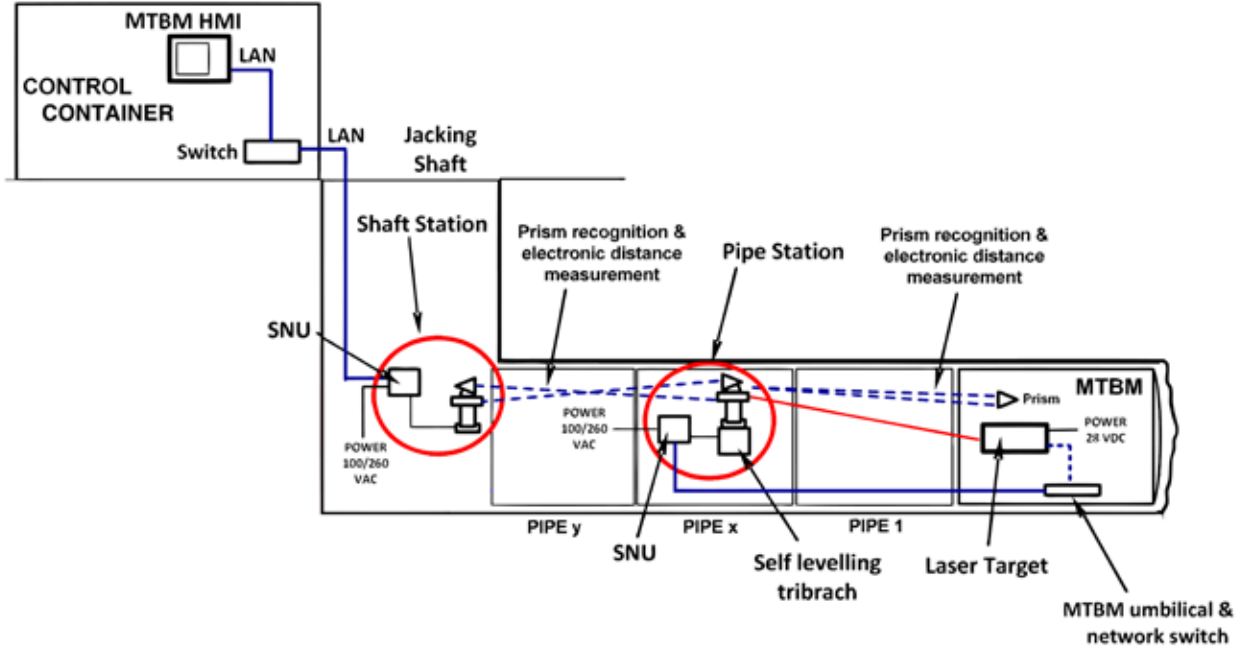
OPERATING GUIDELINES

⚠ 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. 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.
14. Never look at the sun through the telescope. Loss of eyesight could result and potential instrument damage can occur.
15. Do not look at reflected sunlight from a prism through the telescope. Loss of eyesight could result.
16. Tighten the adjustment tribrach clamp securely. Failure to properly secure the clamp could result in the tribrach falling off while being carried.
17. 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.
18. Check total station level often and check line and grade alignment on target monitor often to avoid misalignment.
19. Lock out electrical power at the source (generator) before servicing electrical components.
20. 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.
21. 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 a maximum 150 - 250 linear feet (46 - 76 m) with a self leveling tribrach. Additional pipe stations are added as required along the curved tunnel 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

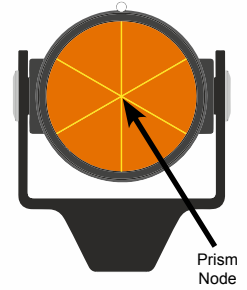


Pipe Station In Tunnel

AZ100 SHAFT PRISM GUIDELINES

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

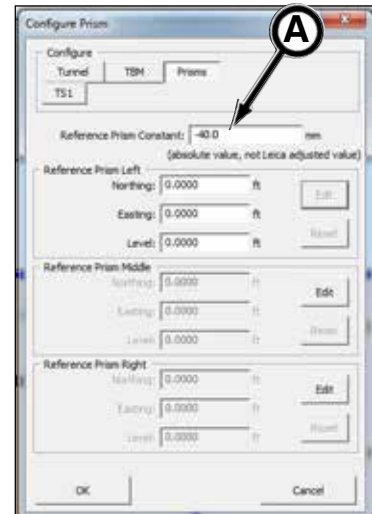
In general, the prisms must be in line of sight of the shaft total station (theodolite), as far from shaft station as possible and the prisms as far away as possible from each other. Prisms must be oriented so the total station can line up with the laser beam squarely (perpendicular) to prism. A curve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



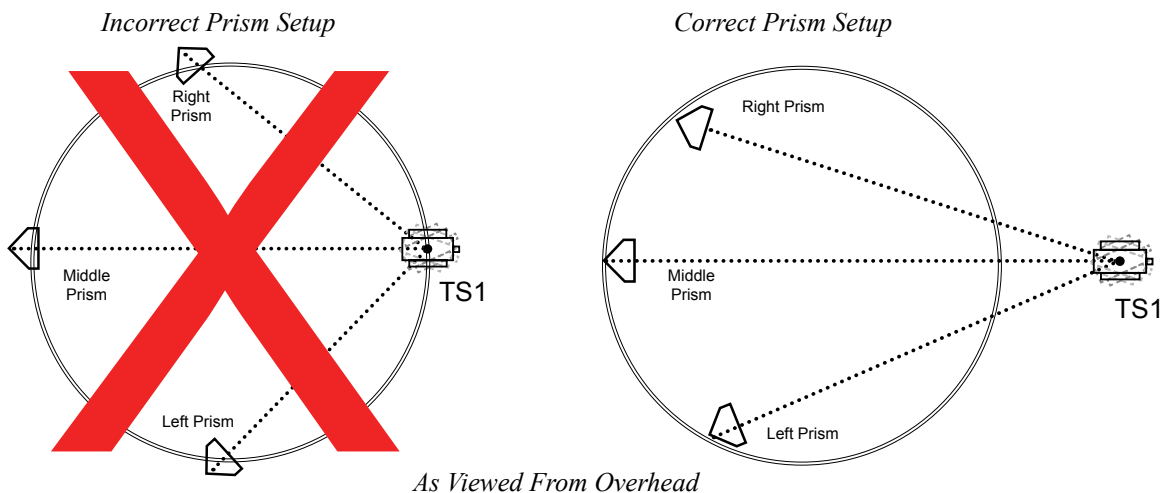
Specifically:

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 three 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. The middle prism MUST be as close as possible to the tunnel alignment to ensure minimal total station angular error during rotation.
7. All prisms MUST be facing TS1 (shaft station).
8. The three prisms and the TS1 (shaft station) CANNOT be in a circle as viewed from above. In rare occurrences, this "circle phenomenon" causes mathematical equations within the system to degrade the accuracy of the reference check causing errors. Note, the total station cannot lie on the unique circle created by the three prisms (three points define a circle).

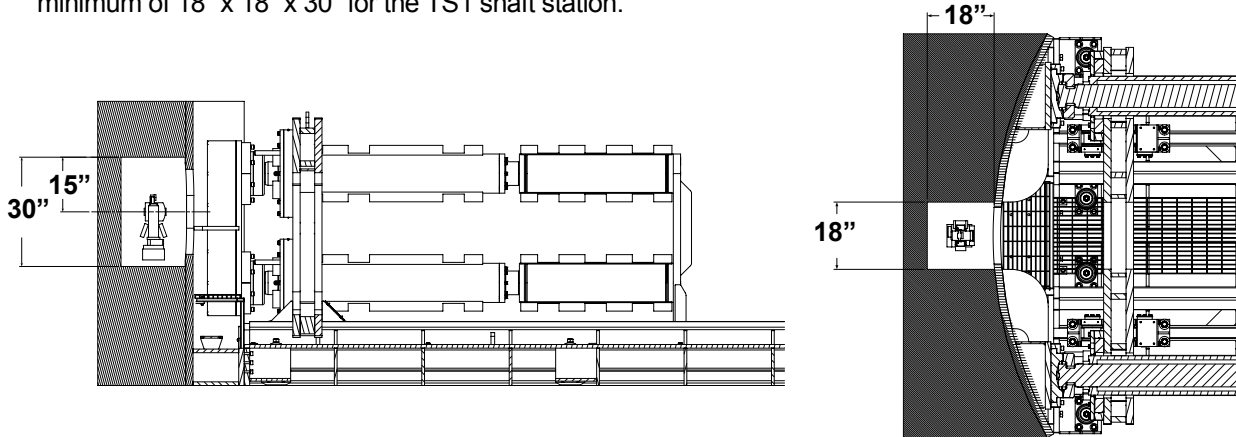


ASSEMBLING THE SHAFT STATION (LAUNCH SHAFT)

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.

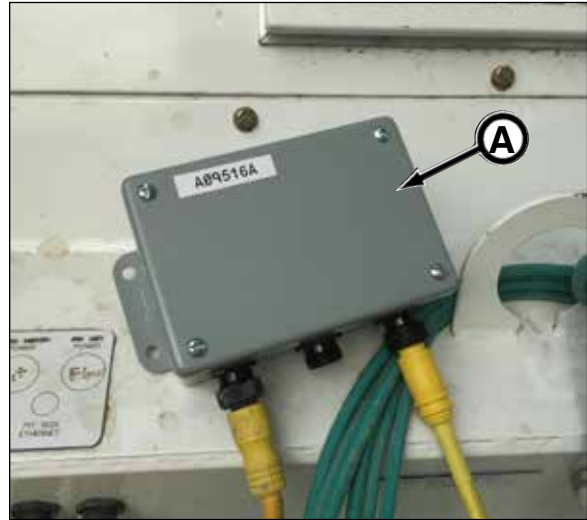


7. Install SNU (F). The SNU must be installed within 10 ft (3 m) of the total station.
8. Connect power (yellow) and ethernet (green) cables from control container to SNU.

(continued on next page)

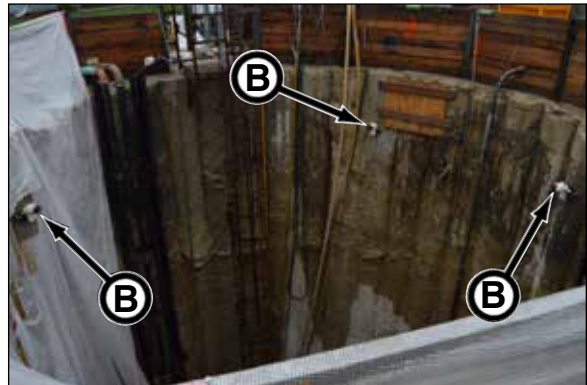
NOTICE A power split box (A) must be installed on control containers and MTBMs that are not equipped with extra 3 pin 120V power connections for the guidance system.

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



10. Install three 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.



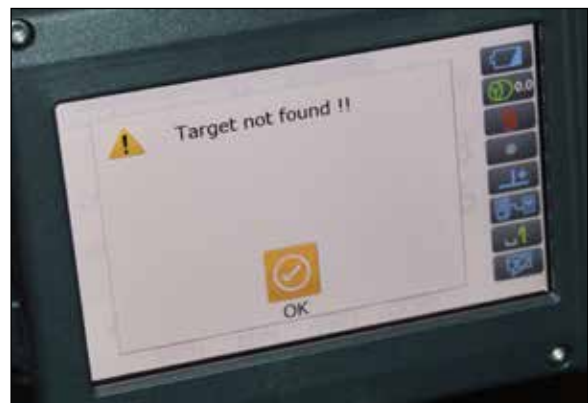
8. Press SRCH (B). The total station will begin searching for the prism.



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)

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 prisms.

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



TopCon® Total Station Sokkia® Total Station

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.



10. Proceed to System Setup Using AZ100 Software Program in this section.

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.



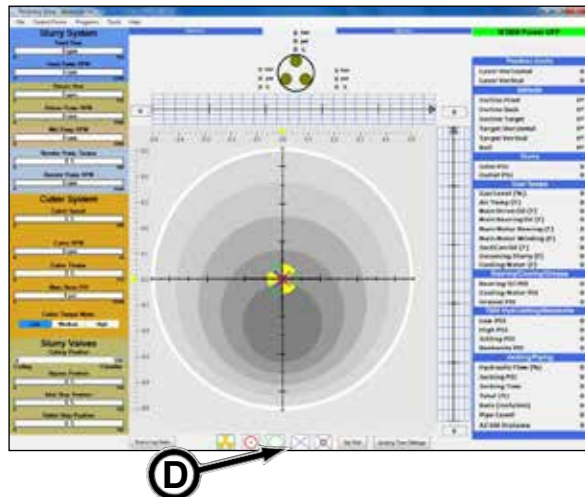
NOTICE A power split box must be installed on the MTBM front section box that is not equipped with an 3 pin 120V power connections for the guidance system.

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 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).

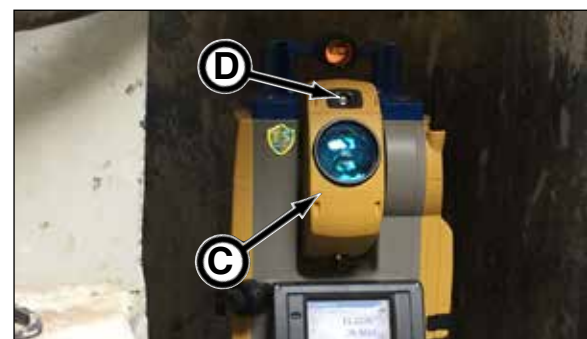


TopCon® Total Station



Sokkia® Total Station

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)

4. The electronic level window will be displayed.

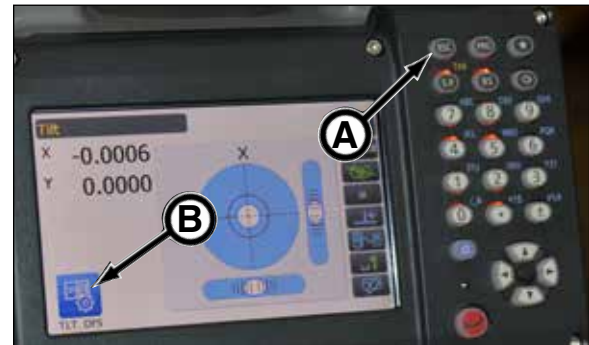
Level total station using the tribrach leveling foot screws until the bubble is centered in the circular level. The bubble moves towards the screw that is turned clockwise.

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

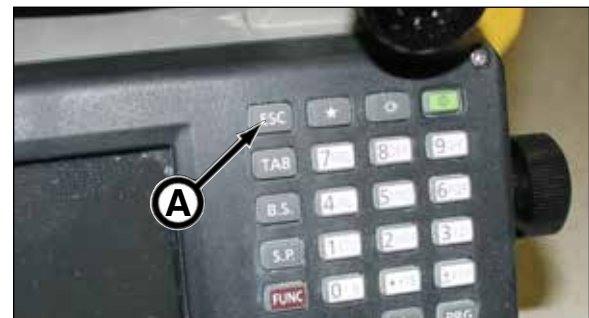
5. Press the ESC key (A) to get to the main menu (or press TLT_OFS (B) on level window to go directly to the tilt offset window).



TopCon® Total Station

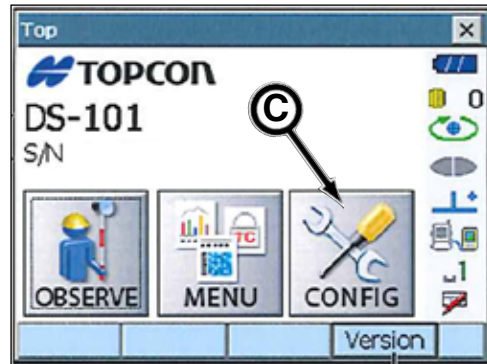


Sokkia® Total Station

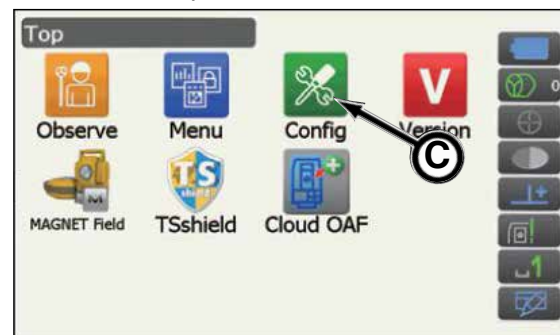


TopCon® Total Station

6. Select CONFIG (C).



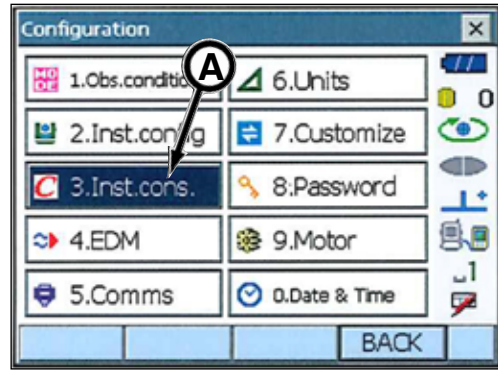
TopCon® Total Station



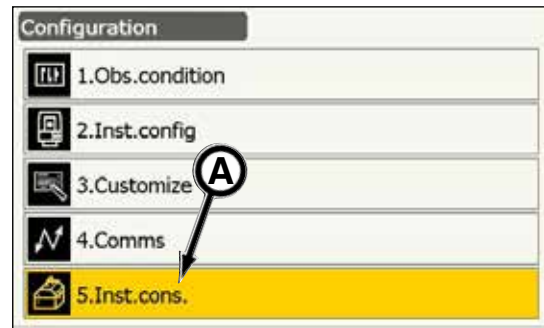
Sokkia® Total Station

(continued on next page)

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

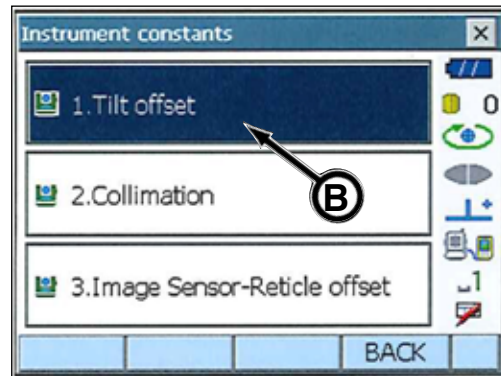


TopCon® Total Station

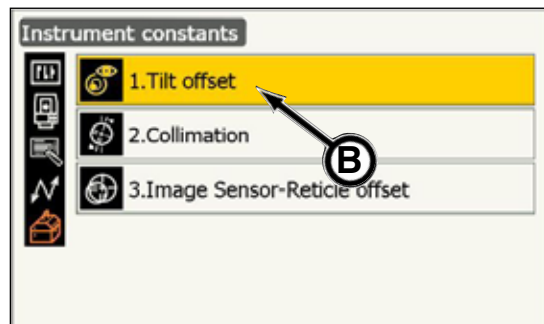


Sokkia® Total Station

8. Select 1. Tilt offset (B).



TopCon® Total Station



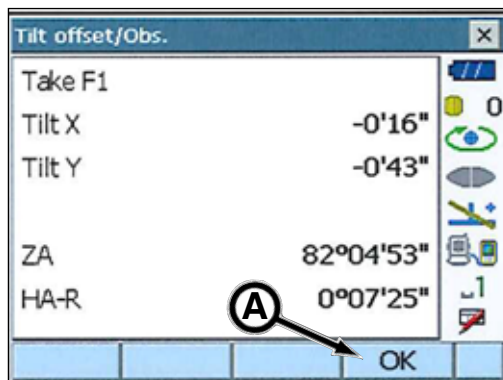
Sokkia® Total Station

(continued on next page)

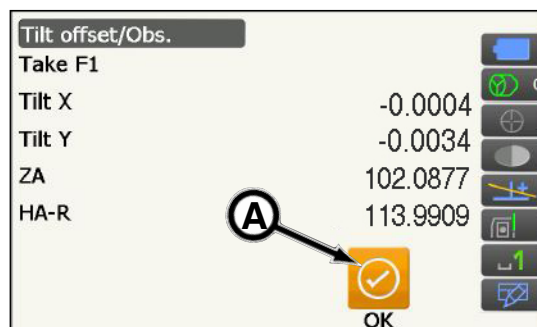
CAUTION Do not look through the telescope eyepiece after selecting OK. The motor drive will operate resulting in possible eye injury if struck by the rotating telescope.

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.

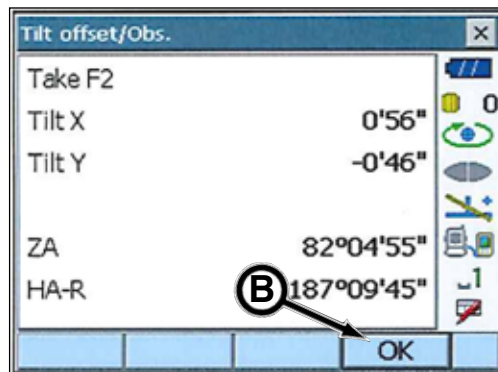


TopCon® Total Station

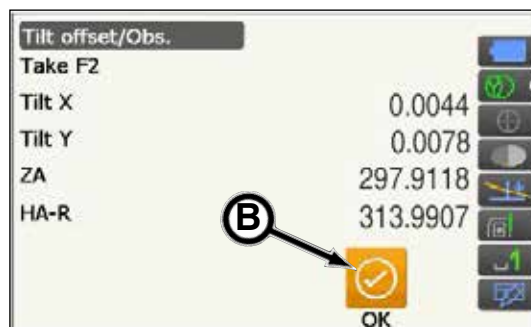


Sokkia® Total Station

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



TopCon® Total Station

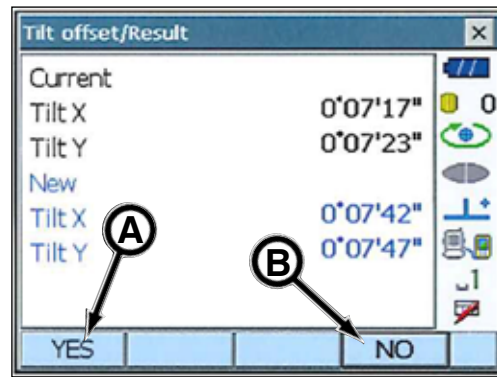


Sokkia® Total Station

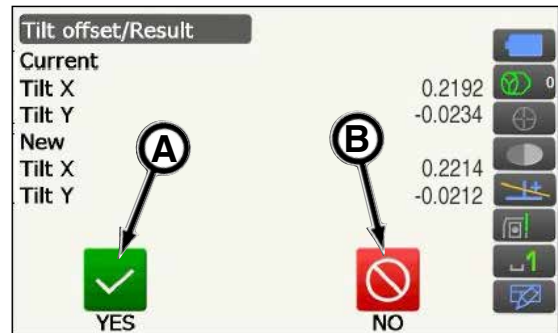
(continued on next page)

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.



TopCon® Total Station



Sokkia® Total Station

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

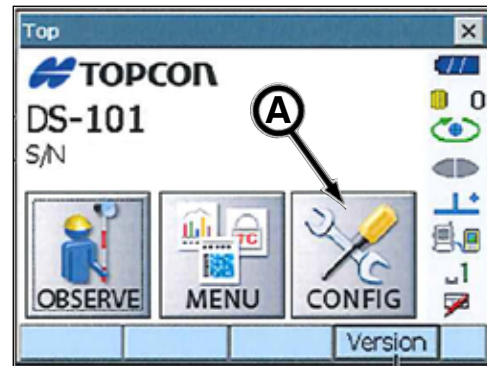
Refer to your Total Station instruction manual for more information on checking the collimation.

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).



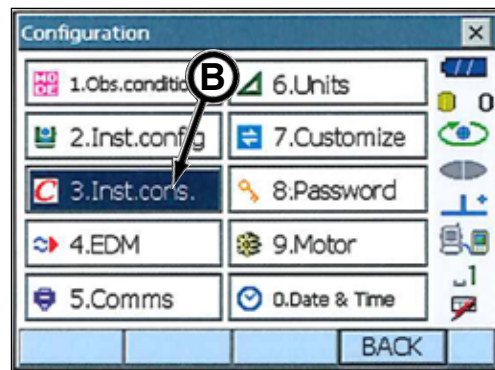
TopCon® Total Station



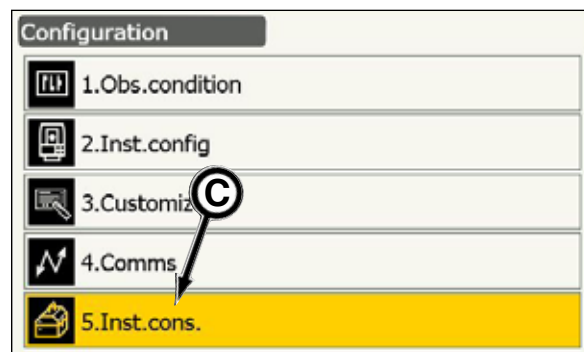
Sokkia® Total Station

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

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



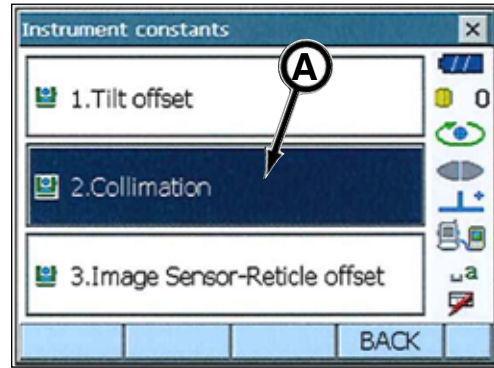
TopCon® Total Station



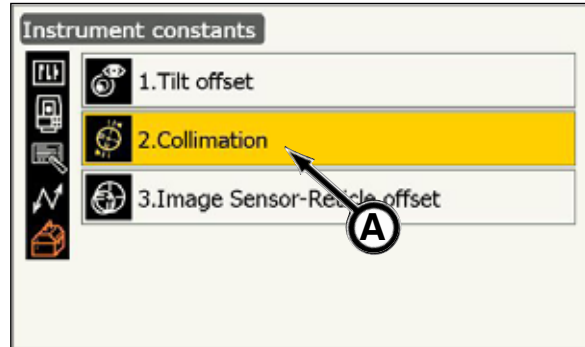
Sokkia® Total Station

(continued on next page)

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.



TopCon® Total Station



Sokkia® Total Station

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).
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).

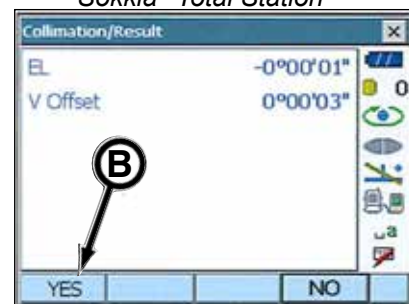


TopCon® Total Station

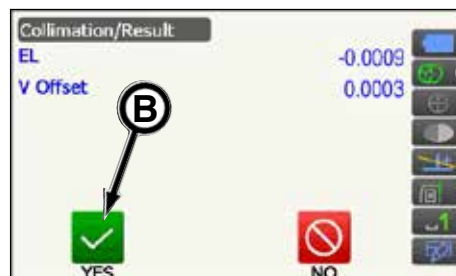


Sokkia® Total Station

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



TopCon® Total Station



Sokkia® Total Station

LOADING DRIVE DTA (DESIGNED TUNNEL AXIS)

Before the start of any new tunneling project, a DTA (Designed Tunnel Axis) file must be loaded into the AZ100 computer system. The DTA is simply the file containing the planned tunnel coordinate data. This is critical data for the tunnel. DO NOT change any of the data on the file. Tunnel errors will occur.

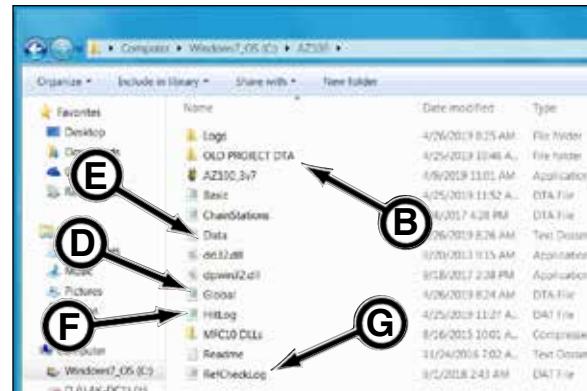
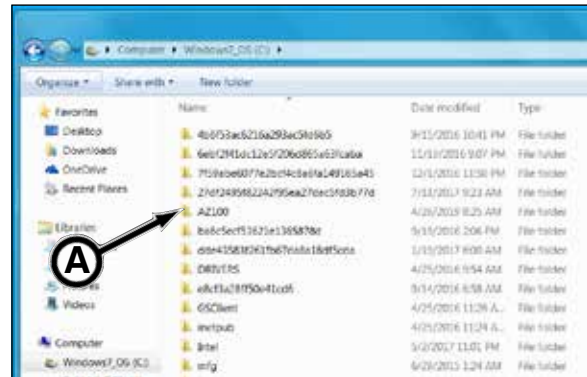
1. In the computer, open local disk (typically C drive) and double click AZ100 folder (A).
2. Create a new folder (if not already done so) and name it OLD PROJECT DTA (B) or Old Projects (C).
3. Cut the existing Global file and paste into OLD PROJECT DTA folder. Rename file to Global_projectname. This will retain your old project file data.
4. Get the new DTA file from Akkerman. Save the new DTA file in the AZ100 folder on your local disk (C drive). The file MUST be named Global.dta (D). Rename file if necessary.

IMPORTANT: Some computers have the file extension hidden, if so do not repeat the .dta extension in the file name.

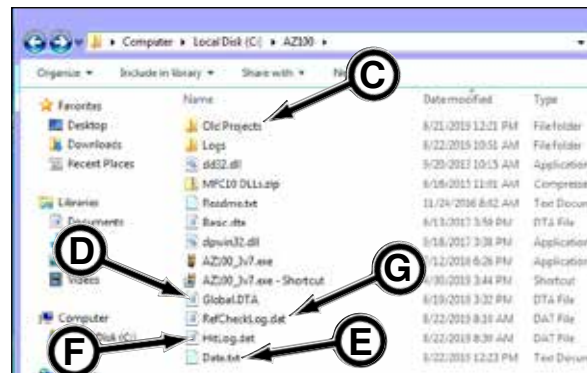
5. Locate the data.txt file (E) and rename it data_projectname.txt. Cut and save in OLD PROJECT DTA or Old Projects folder. A new data.txt file will be created when the AZ100 program is opened.

NOTICE If the data.txt, HitLog.dat and RefCheckLog.dat files are not renamed, the files will accumulate data from previous projects by date.

6. Locate the HitLog.dat file (F) and rename it HitLog_projectname.dat. Cut and save in OLD PROJECT DTA or Old Projects folder. A new HitLog.dat file will be created when the AZ100 program is opened.
7. Locate the RefCheckLog.dat file (G) and rename it RefCheckLog_projectname.dat. Cut and save in OLD PROJECT DTA or Old Projects folder. A new RefCheckLog.dat file will be created when the AZ100 program is opened.



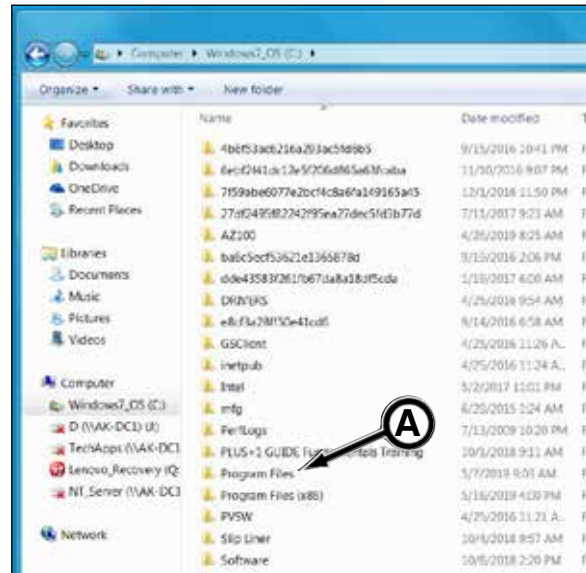
AZ100 Folder With File Extensions Hidden



AZ100 Folder With File Extensions Shown

(continued on next page)

- In the local disk (C drive), double click Program Files folder (A),

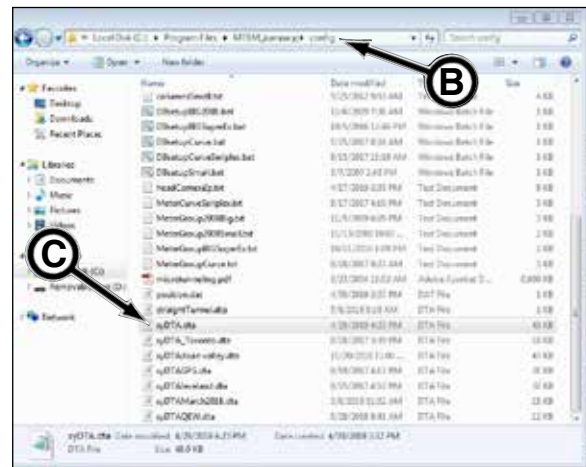


- Double click MTBM_*companyname*, and double click config folder as shown in address bar (B).

- Rename the existing xyDTA.dta file to xyDTA_*projectname*.

- Copy or drag and drop the new xyDTA.dta file (from Akkerman) into config folder.

- Close all folders and proceed to System Setup Using AZ100 Software Program in this section.



SYSTEM SETUP USING AZ100 SOFTWARE PROGRAM

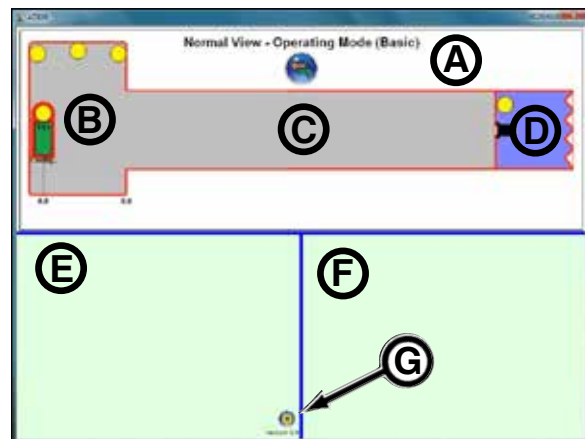
IMPORTANT: Once the shaft station total station is initially brought to the job site, the Tilt Offset and Collimation must be checked. If subjected to strong vibration or instrument has been bumped, recheck.

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:

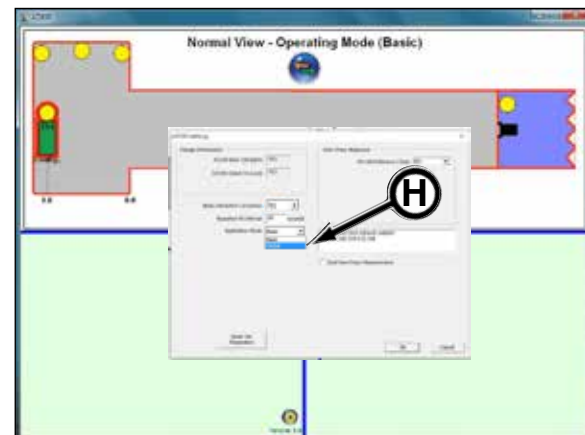
- a. Tunnel View Pane (A)
 - shows a representation of the tunnel layout; launch shaft (B), tunnel (C) and tunnel boring machine (D).
- b. Control Pane (E)
 - shows various controls; controls will vary depending on mode selected.
- c. Information Pane (F)
 - shows general information about the currently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

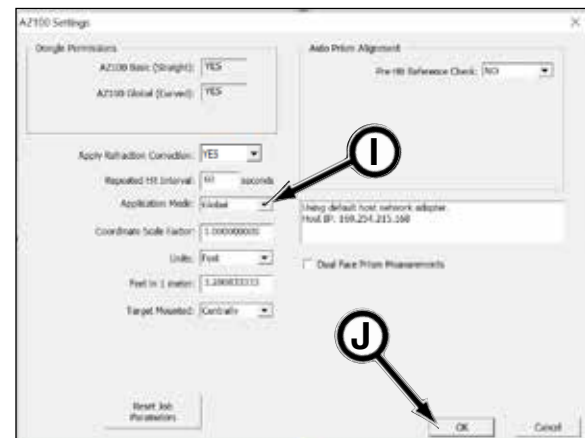


5. When changing Application Mode to GLOBAL (I), the AZ100 Settings window will expand to include curve data fields.

6. Update the setting fields as follows:

Coordinate Scale Factor: value from surveyor
 Unit: select Feet or Meter*
 (*this instruction will refer to Feet)
 Feet in meters: 3.280833333 **DO NOT CHANGE**,
 this is an auto fill field.

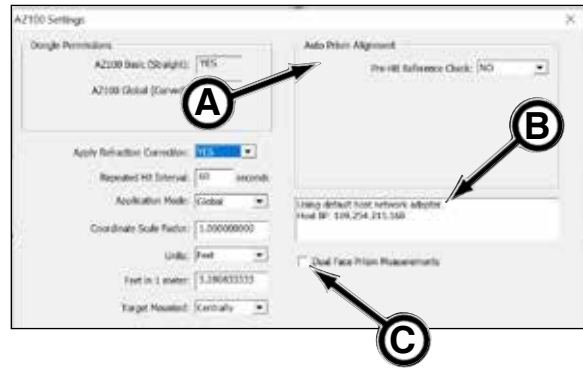
7. Click OK (J).
- (continued on next page)



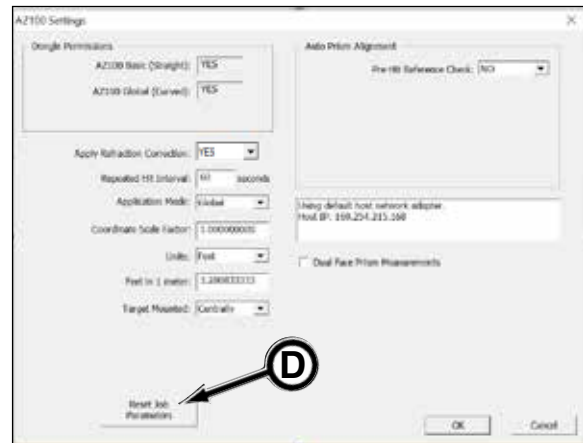
NOTICE The Auto Prism Alignment (A) used when jacking loads cause shaft movement. Refer to Auto Prism Alignment later in this section.

NOTICE The IP address information (B) is used for troubleshooting by Akkerman.

NOTICE Dual Face Measurement (DFM) (C) reduces measurement error but increases measurement time. The DFM is only used in difficult measurement applications or when comparing and adjusting to a surveyor's measurements. Click the Dual Face Measurement box as needed..



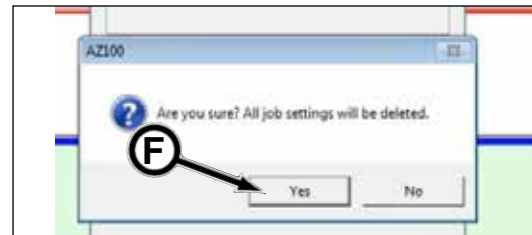
IMPORTANT: When starting a new tunnel project, be sure to clear previous tunneling project data from the AZ100 program by clicking Reset Job Parameters button (D). Failure to do so will result in utilizing incorrect data for the new tunnel project. Refer to Reset Job Parameters in this section.



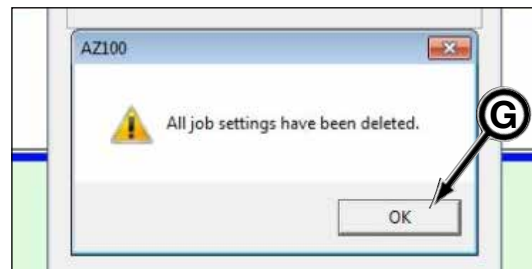
Click Yes button (E) to continue to clear job parameters.



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



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

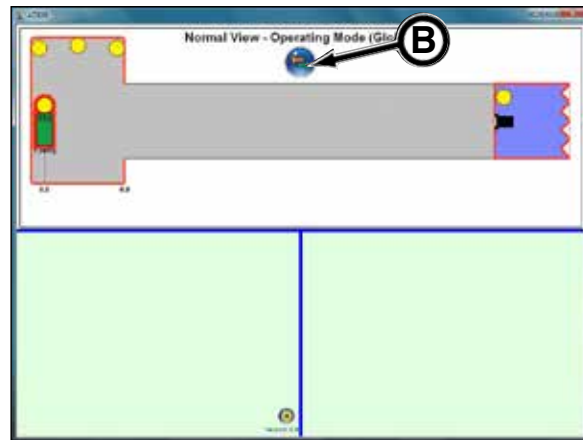


(continued on next page)

Click OK button (A).

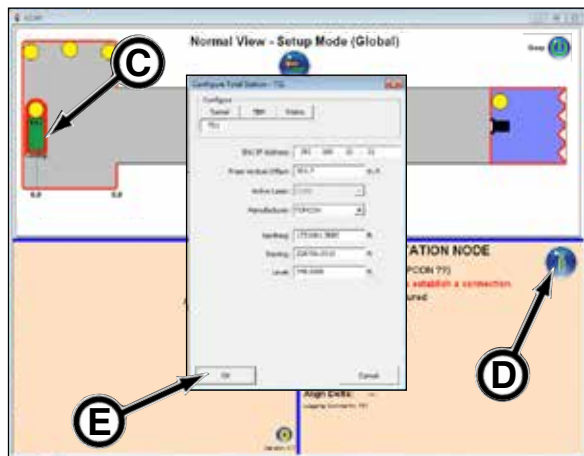


7. The red border around the tunnel will disappear indicating the tunnel is configured.
8. Click switch button (B) to change view from Normal View - Operating Mode to the Normal View - Setup Mode screen.



9. Click on TS1 icon (C) and click information button (D). 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 appropriate IP address labeled on the SNU plugged into TS1.
- b. In the **Prism Vertical Offset** field, enter 351.7 th. ft. when using the TOPCON DS-101AC or Sokkia® iX series 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 for both TopCon and Sokkia total stations.
- e. Enter data in **Northing, Easting, Level** fields if information is available. Otherwise leave fields at 0. This preliminary information is used to ease the prism alignment process (starting in step 25) by locating the total station in a reasonable orientation to the shaft.

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

(continued on next page)

NOTICE

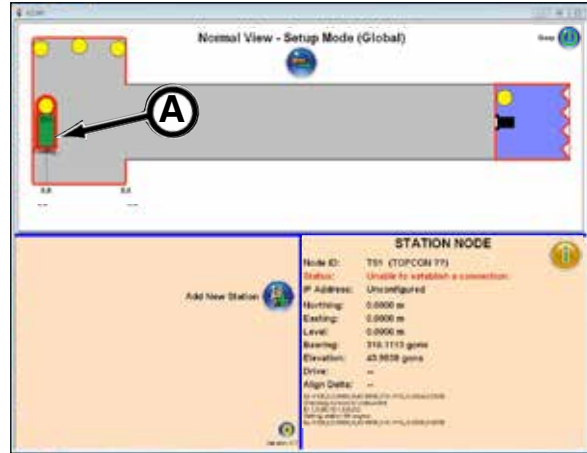
If the TS1 icon is shown with a red (unable to establish a connection) or orange (connection established but no reply) border, then the SNU has not been properly connected. See below for troubleshooting.

• **TS1 with red border (A)**

status: Unable to establish a connection.

Indicates the following:

- a. The shaft station SNU power and comm cables are not connected to the total station or the control container.
- b. The 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.
- c. Wrong IP address was entered.

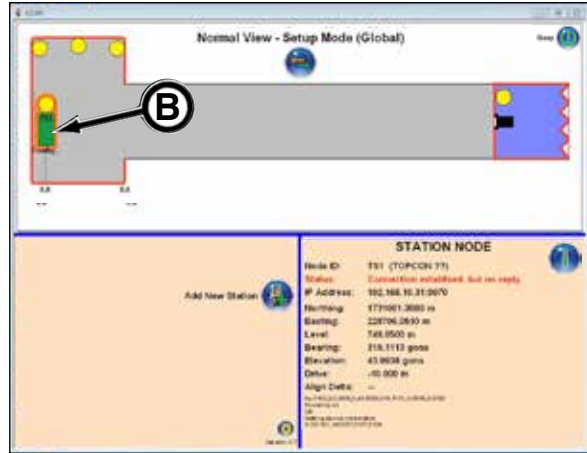


• **TS1 with orange border (B)**

status: Connection established but no reply.

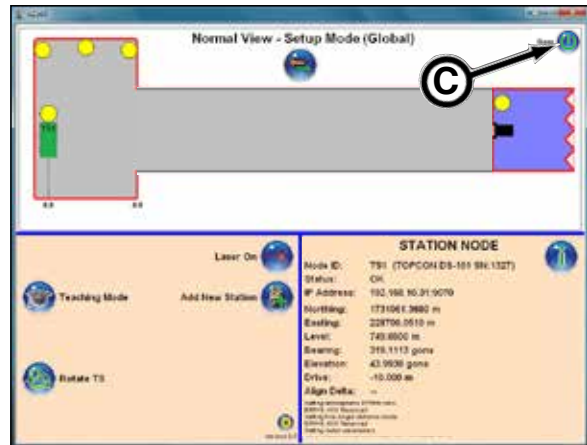
Indicates the following:

- a. The shaft station SNU is connected via the power (yellow) and comm (green) cables to the control container.
- b. The shaft station SNU power (yellow) or comm (green) cables are connected to the control container but the power/comm (gray) cable is not connected to the total station.



NOTICE

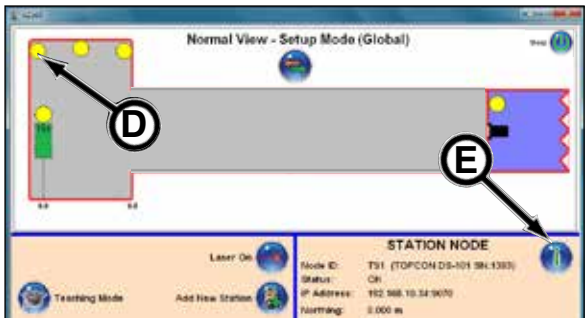
There is a sleep mode (C) feature that allows the total stations to complete any background tasks before shutting off power to prevent data corruption. This is recommended when there are four or more total stations in the tunnel.



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

NOTICE

The Laser On / Off button will be visible when any of the total stations are selected. Click desired total station to control laser.

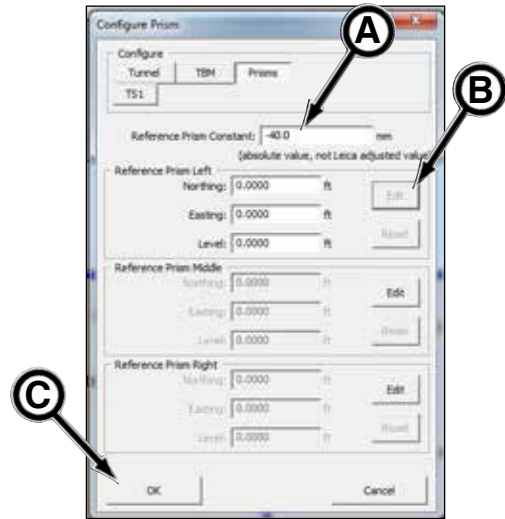


- 12. Click on left prism (D).
- 13. Click Information button (E) or double click the prism.

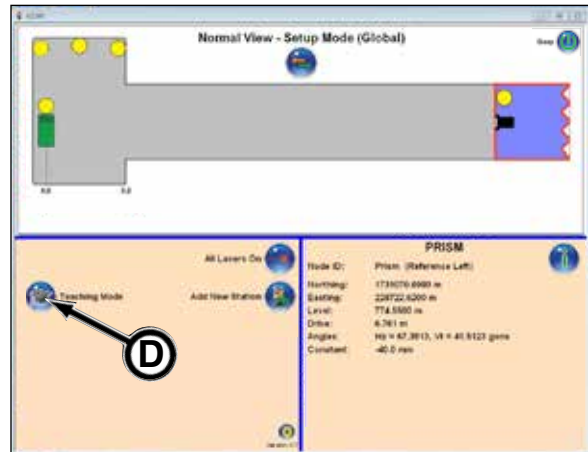
(continued on next page)

14. The configure Prism window appears.
15. Check the reference prism constant value (A). The value is provided by prism manufacturer.
16. Click Edit button (B). Enter the appropriate (left, middle or right) prism information. The data (northing, easting and level) is provided by the certified surveyor.

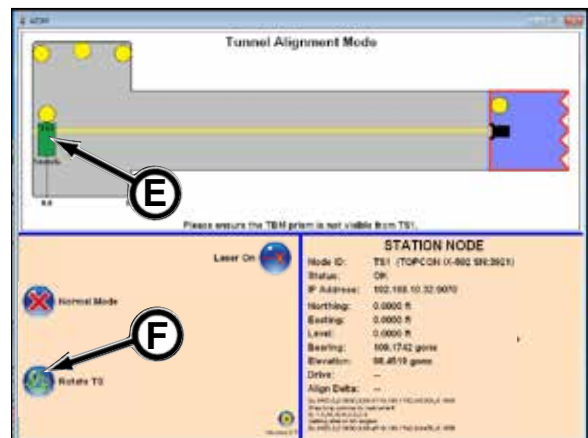
IMPORTANT: It is critical the data is entered correctly for the proper prism location. Incorrectly entering prism information will result in reference check failure. Thus, you will not be able to proceed in the configuration process.



17. Repeat step 16 for other prisms.
18. Verify the entered prism data. When all three prism data is correct, click OK button (C).
19. The red border around the shaft is no longer visible indicating the shaft is now configured.
20. The Normal View - Setup Mode window appears.
21. Click Teaching Mode button (D).

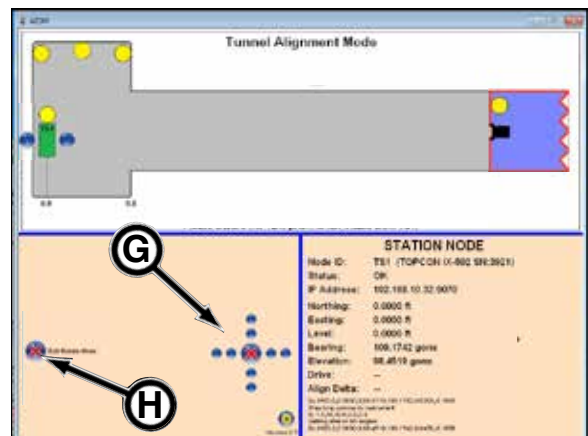


22. The Tunnel Alignment Mode window appears.
23. Click TS1 (E).



24. Click Rotate TS button (F). **IMPORTANT: When in rotate mode DO NOT click prism, otherwise errors will result.**
25. With an assistant to help in positioning the total station, use the arrow buttons (G) as needed to point the total station at the most closely aligned prism to tunnel heading (typically middle prism), close enough so the total station will not find any of the other two prisms. When positioning total station, do not physically move total station, always use the arrow buttons to prevent bumping the total station.

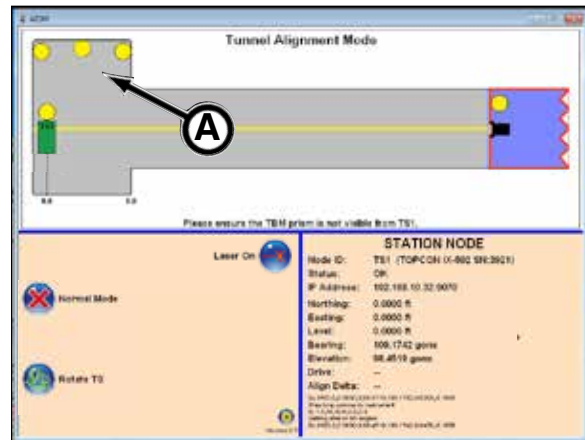
Arrow Button control:
 inside buttons - slow speed
 outside buttons - fast speed
 Must press the middle Red X button to stop rotation.



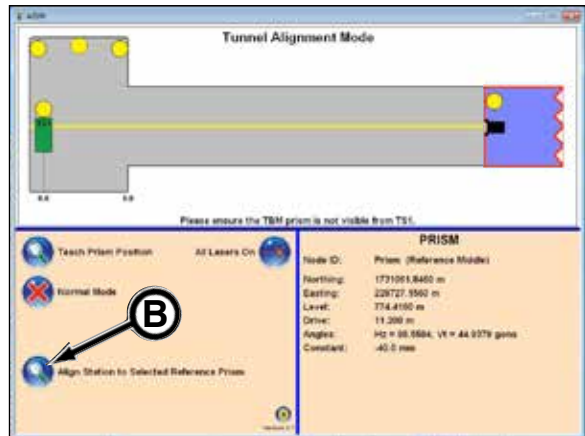
26. Click Exit Rotate Mode button (H).
 (continued on next page)

27. The Tunnel Alignment Mode window reappears.

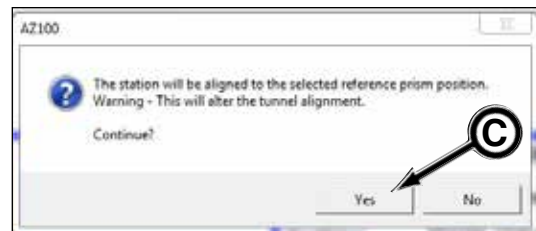
28. Click prism (A), the one aligned in step 25.



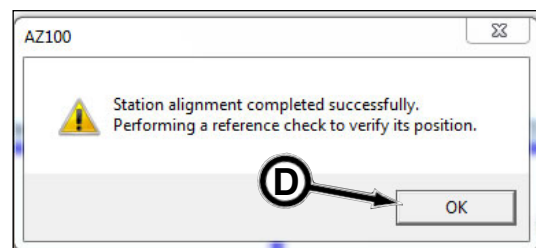
29. Click Align Station to Selected Reference Prism button (B).



30. The AZ100 message window appears that the total station will align to the selected reference prism position. Continue? Click Yes button (C). The total station will now search for prisms.



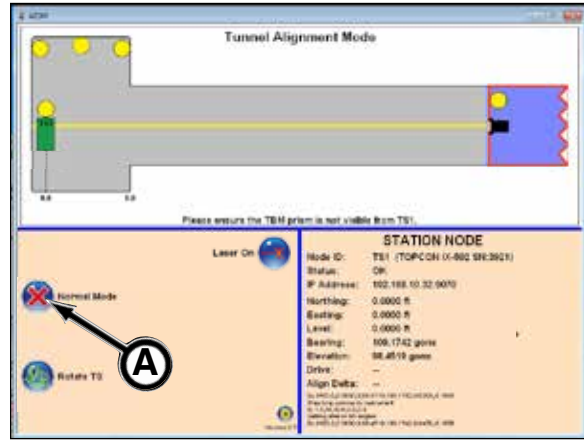
31. The AZ100 message window appears once the station alignment is completed successfully. It will now perform a reference check to verify its position. Click OK button (D).



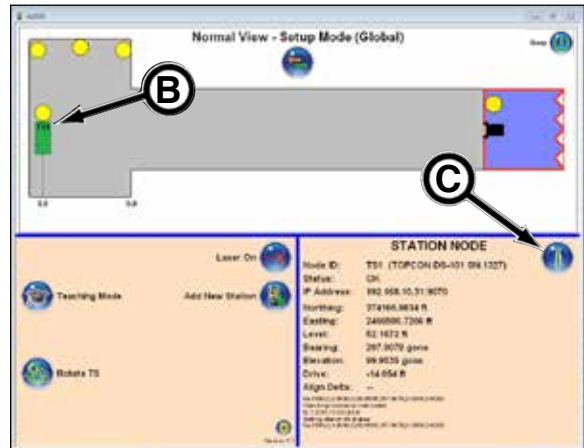
NOTICE If prism has a red border (E), the prism location has an error. If prism is not found, the reference check will terminate. Repeat reference check and/or be sure there is line of sight between the TS1 and prism.



32. The Tunnel Alignment Mode window appears. Click Normal Mode button (A).



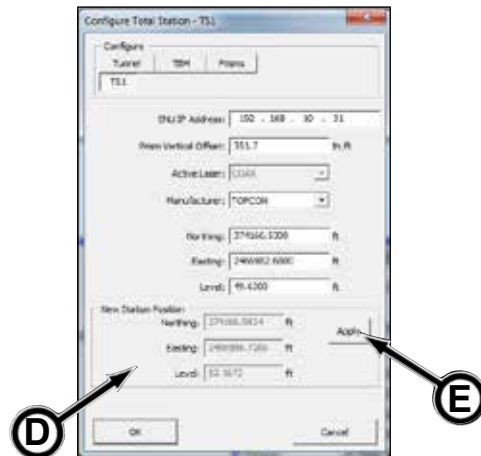
33. The Normal View - Setup Mode window appears.



34. Click TS1 (B). Click Information button (C).

35. The Configure Total Station -TS1 window appears showing the new station position (D). Verify that the information is correct. Click Apply button (E) to update to the new station position.

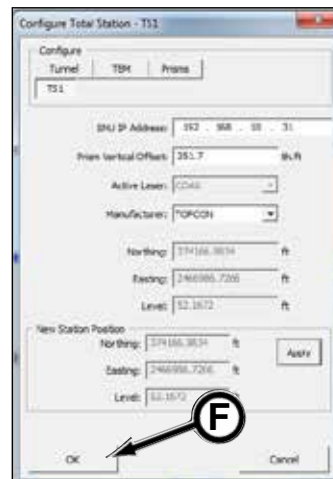
NOTICE The existing and new station position values may not exactly match (as shown) due to total station surroundings. Though the values should be virtually the same.



36. After clicking Apply, the Northing, Easting and level fields will be grayed out indicating the new station position was applied.

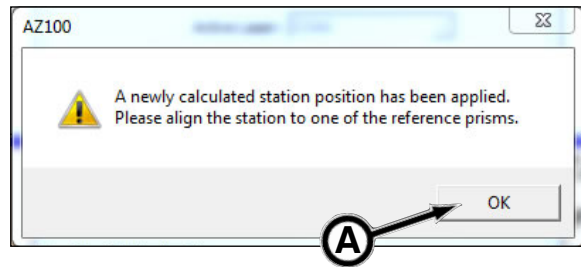
Verify that the information is correct.

37. Click OK button (F).



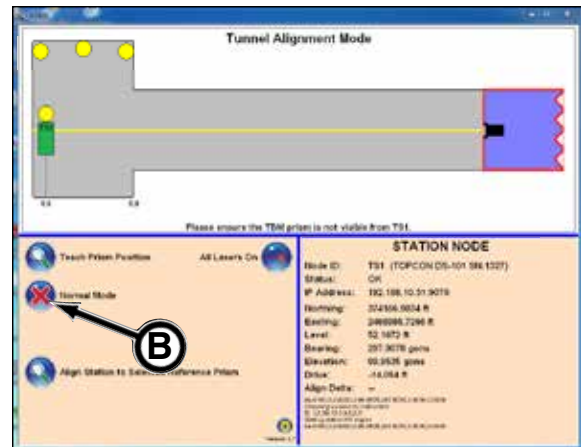
(continued on next page)

38. The AZ100 message window appears stating the newly calculated station position has been applied and to align the station to one of the reference prisms. Click OK button (A).

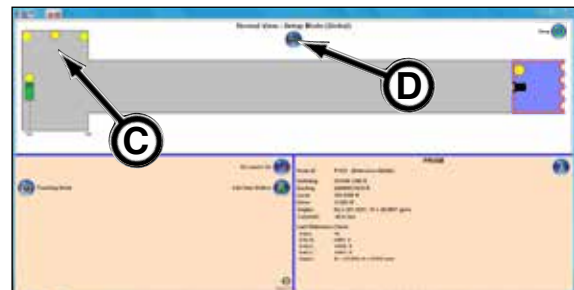


39. The Tunnel Alignment Mode window appears.
40. Click Normal Mode button (B).

IMPORTANT: DO NOT click Teach Prism Position button. Doing so will require re-entering survey prism positions.



41. Click a prism (C) to reveal Last Reference Check.
42. Click switch mode button (D).

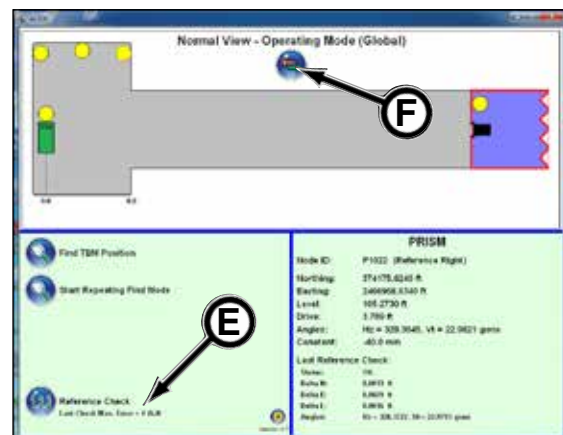


43. The Normal View - Operating Mode window will appear.

NOTICE If there is a red border around prism(s), the prism was not found or the last reference check error (in red text) was too large.

The Last Check Max. Error = (E) displays the overall error from the three prism reference checks in th. ft. Value will be red if the error is too large.

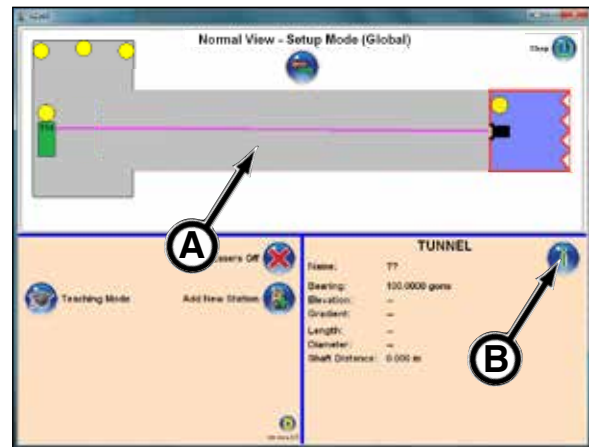
44. Click switch mode button (F).



(continued on next page)
az100curve-050147

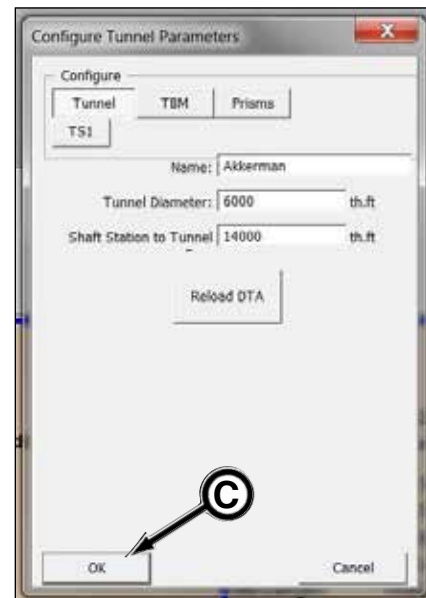
45. In Normal View - Setup Mode screen, click tunnel area (A).

46. Click Information button (B).



47. The Configure Tunnel Parameters window appears. Enter Name, Tunnel Diameter and Shaft Station to Tunnel data.

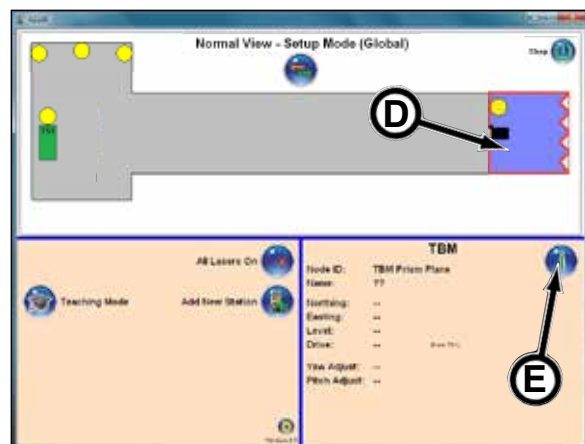
- Type in **Name**: software stores a descriptive name of the tunnel - for information only.
- Type in **Tunnel Diameter** in (th. ft.): software stores the diameter of the tunnel - for information only.
- Type in **Shaft Station to Tunnel** in (th. ft.): software stores the distance of the shaft. If 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).
- Reload DTA: contact Akkerman. This is used only in the event the tunnel plan changed resulting in the need to update the system tunnel data or if the DTA file has been corrupted.



48. Click OK (C) 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.

49. In Normal View - Setup Mode screen, click TBM area (D).

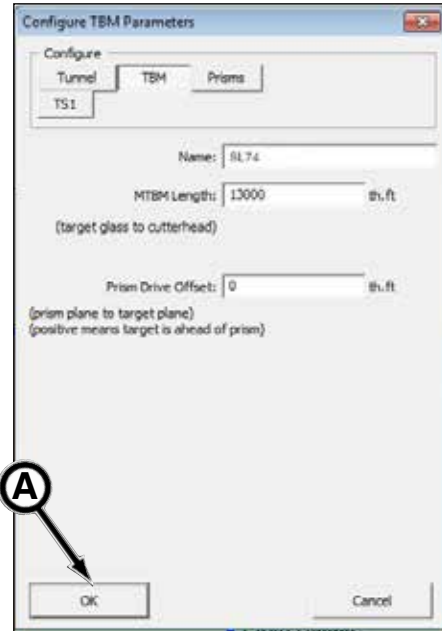
50. Click Information button (E).



(continued on next page)

51. 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 th. ft. Typically the offset is zero (0) unless prism is relocated.



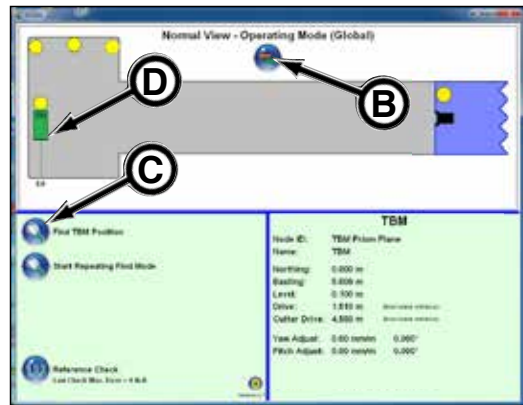
52. Click OK (A). The red border around the TBM will disappear indicating that the TBM is configured.

53. Click switch button (B) to change view to Normal View - Operating Mode.

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

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

c. The TS1 icon will display status text (D) 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.

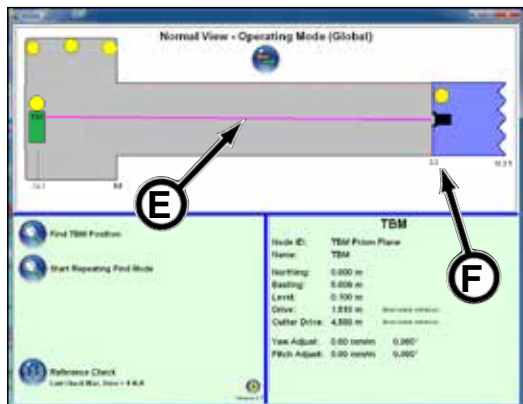


Status text under the station can be:

- **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 (E) will be displayed between the TS1 icon and the TBM.

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



(continued on next page)

NOTICE

While mining, it is recommended to click the Find TBM Position (A) 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 will be updated.

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

NOTICE

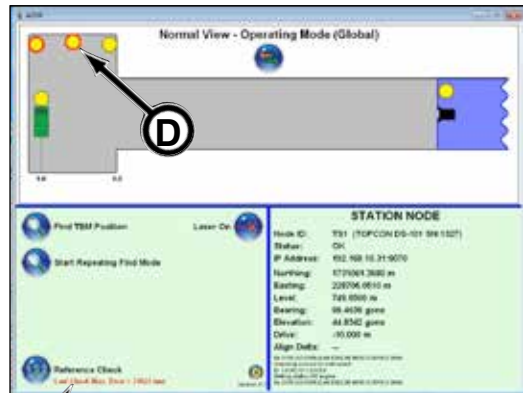
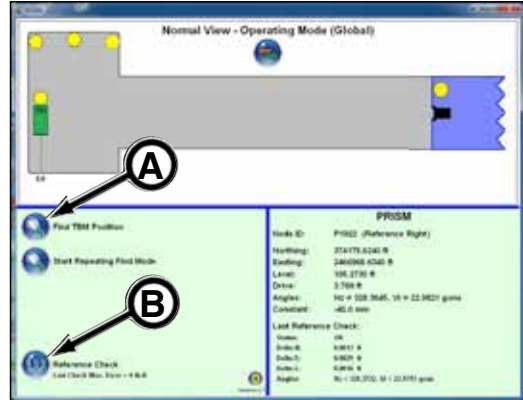
To perform a Reference Check, the check needs to be done at the end of the pipe push:

- while there is stall 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.

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

When a reference check error occurs, refer to Preparing for Performing Reference Checks in this section.

IMPORTANT: 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, perform another reference check. If error in reference check, the alignment must be reestablished by resurveying prism locations to be sure the shaft station is in proper alignment with the surveying marks. Then the shaft station will have to be realigned.

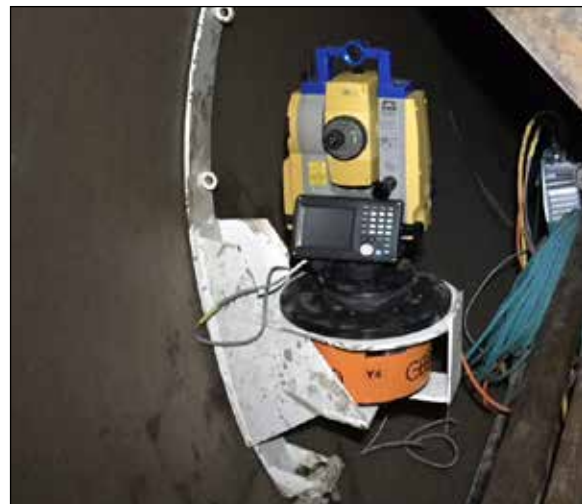


57. A pipe station must be added in the pipe line based on line of sight station layout information (from Akkerman). To install pipe station, refer to Assembling the Pipe Station in this section.

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.

58. Be sure the pipe station telescope and prism is pointing to the shaft station.

IMPORTANT: 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.

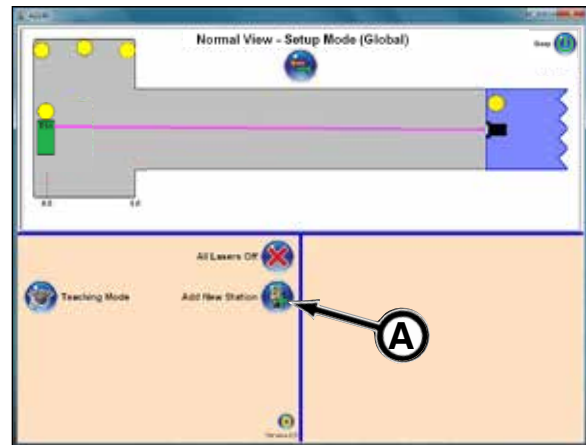


(continued on next page)

59. 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.

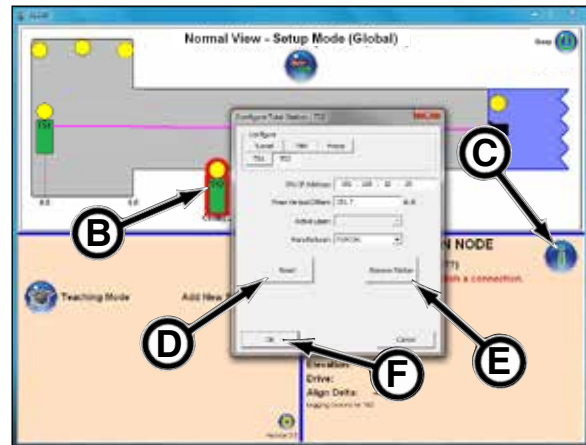
60. Click Add New Station button (A).



61. Click on TS2 icon (B) and click Information button (C). Enter data to configure TS2. This establishes communication to the pipe station.

SNU IP Address: refer to label on SNU
Prism Vertical Offset: 351.7 th. ft.
Active Laser: leave blank
Manufacturer: TopCon

NOTICE There are two extra buttons on the Configure TS2, TS3... windows. **Reset** (D); 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** (E); any station except TS1 can be removed from the system.

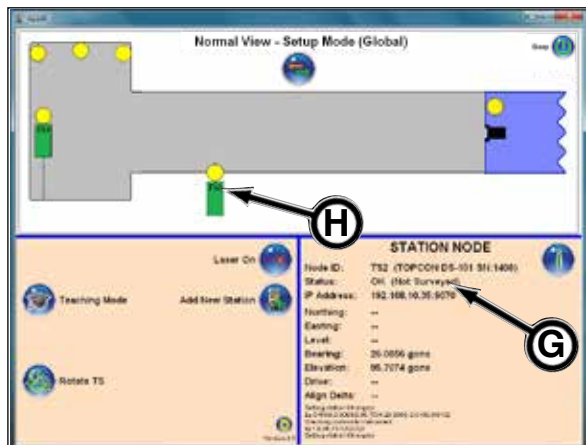


62. Once the data has been entered, click OK (F). The software will now try to connect to the SNU. This may take up to 60 seconds.

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.

63. 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 (G) that it is OK but not surveyed.

The TS2 icon (H) is shown outside of tunnel, not centered within tunnel. Proceed to step 64 to align TS2 in the tunnel.



(continued on next page)

64. 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.

65. Click Find TBM Position button (A). 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.

66. Once the TBM position is found, a line (B) 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.

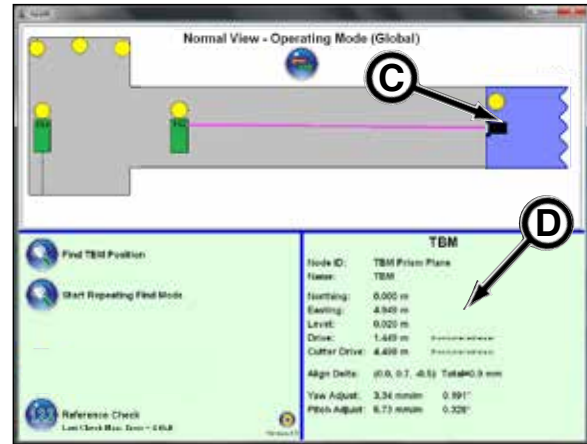
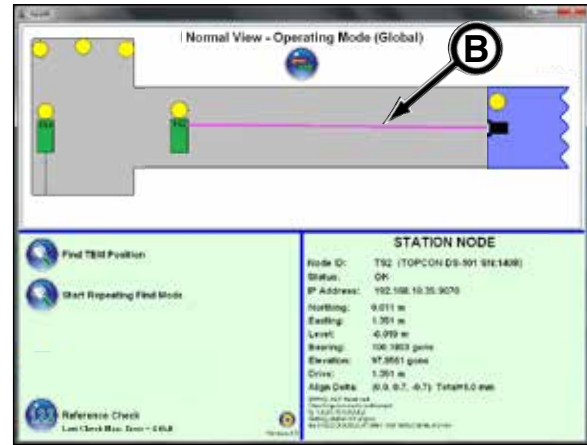
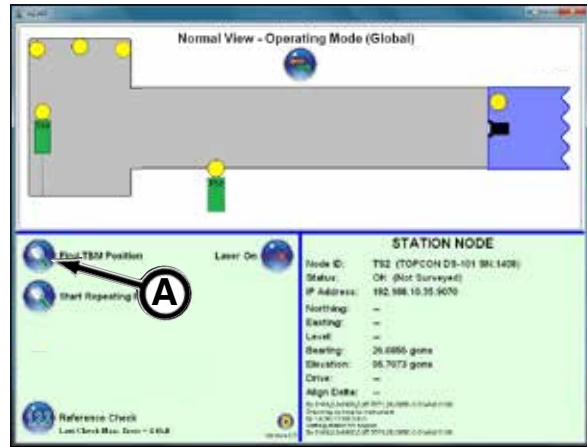
67. Click TBM graphic (C) to display TBM data such as yaw, pitch and other alignment data (D).

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

68. 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.

69. Add additional pipe stations as needed. This is dependent on the tunnel environment. Typically in a straight tunnel, another pipe station should not be required before 2,000 ft. (609 m), though the shaft station and the pipe stations must be within line of sight. Curve tunnels will have additional pipe stations, depending on the tunnel radius, in the tunnel for the line of sight requirement.

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

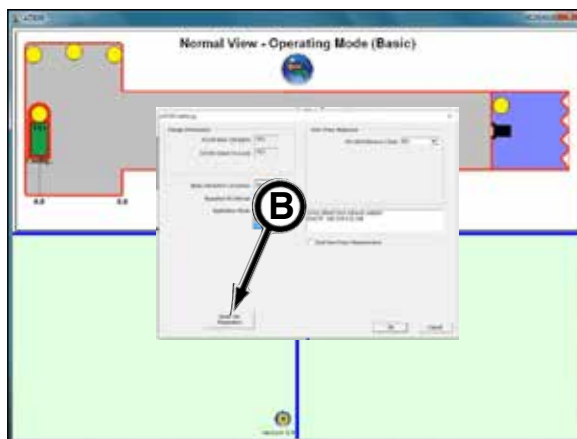
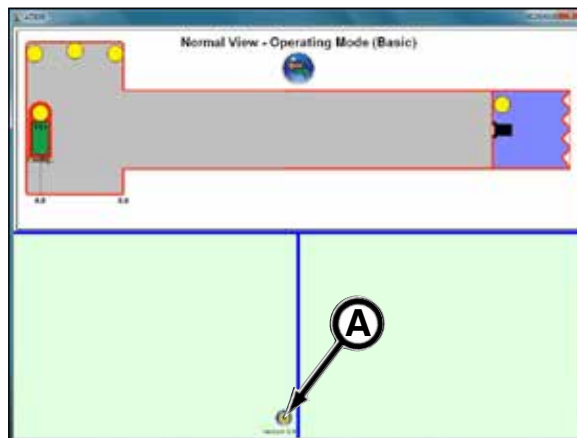


RESET JOB PARAMETERS

IMPORTANT: BEFORE resetting job parameters, the DTA file for the new drive DTA must be loaded into the AZ100 computer system. Refer to Loading Drive DTA in this section.

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.

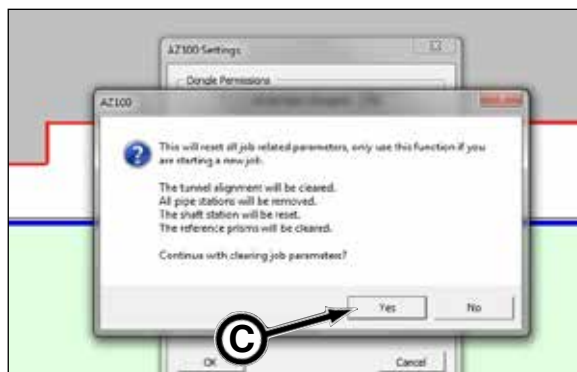
1. With the dongle in the computer USB port, boot up the AZ100 software program by double clicking the AZ100.exe icon on the desktop. The Normal View - Operating Mode screen will appear.
2. Once the main screen is visible and existing data from a previous tunneling project appears, click the settings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



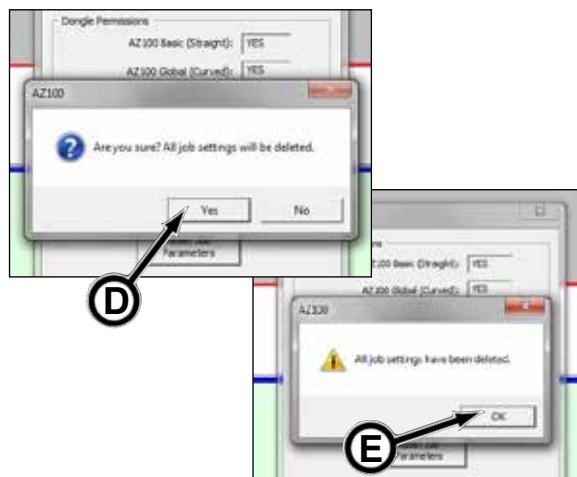
4. The “This will reset all job related” window appears. Click Yes (C).

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.

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.

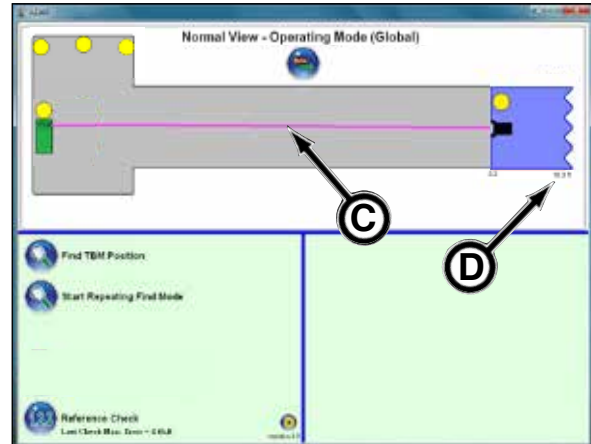
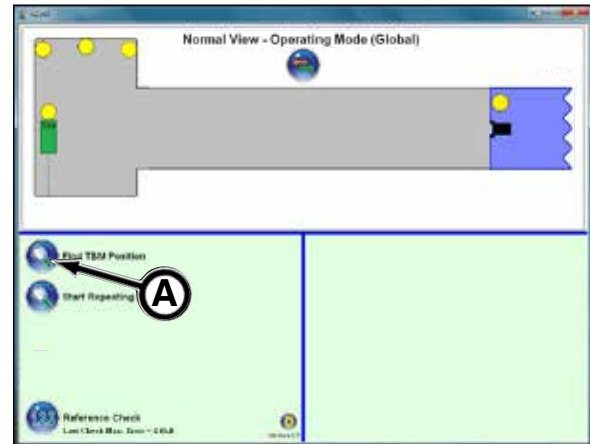
It is recommended, while mining, to click the Find TBM Position button at each dog (relatching the jacking frame skid lock blocks) or approximately every 3 ft. (1 m). Besides confirming the target position, the distance on the AZ100 screen will be updated.

NOTICE

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

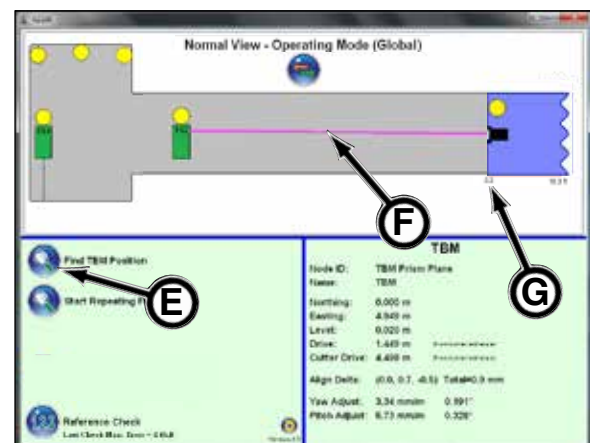
Finding TBM Position SHAFT STATION

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 Reference Check 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 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 Performing Reference Checks 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.

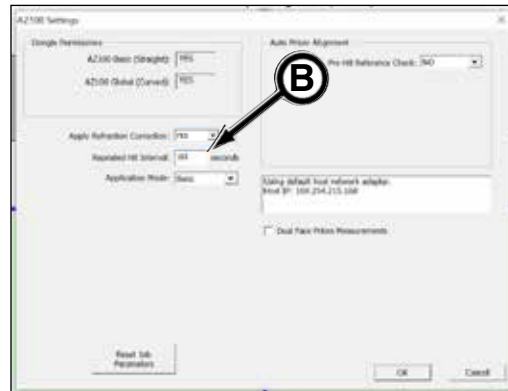
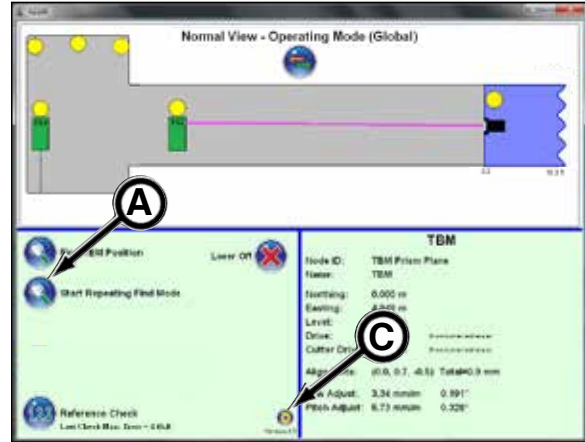


START REPEATING FIND MODE

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.

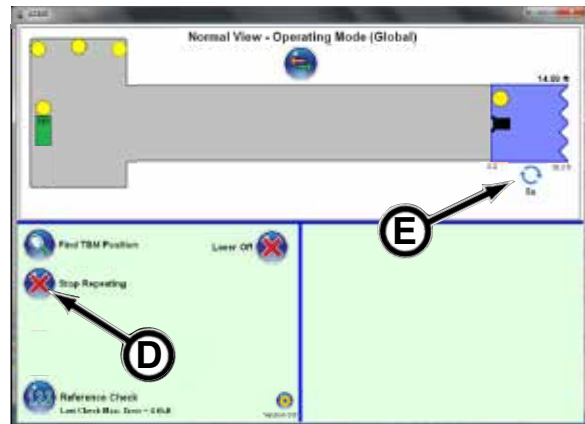
Personnel will have to be removed from the area while the positioning sequence is active due to the laser light.

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.

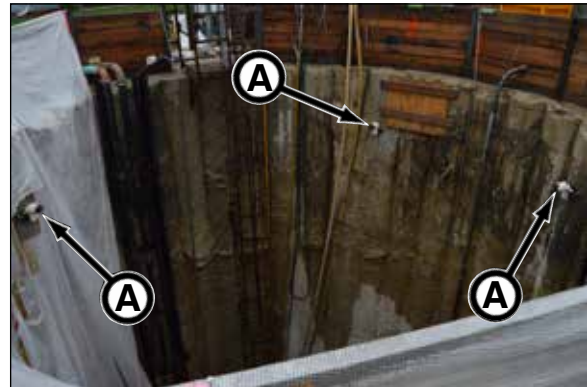


PERFORMING REFERENCE CHECKS

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

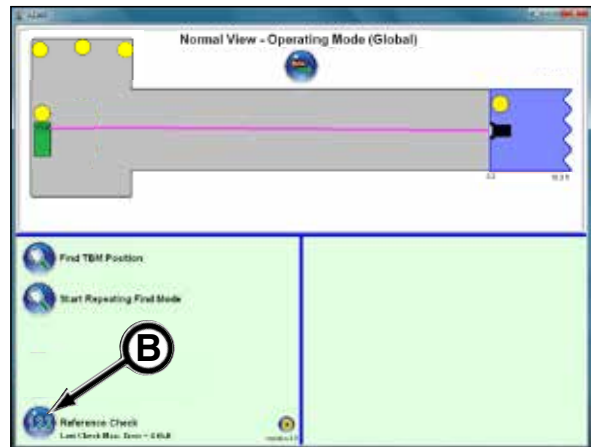
NOTICE To perform a Reference Check, the check needs to be done at the end of the pipe push:

- 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.

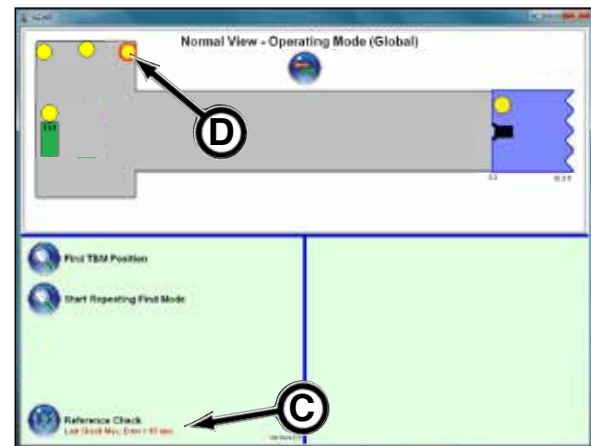


Shaft Prisms

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.



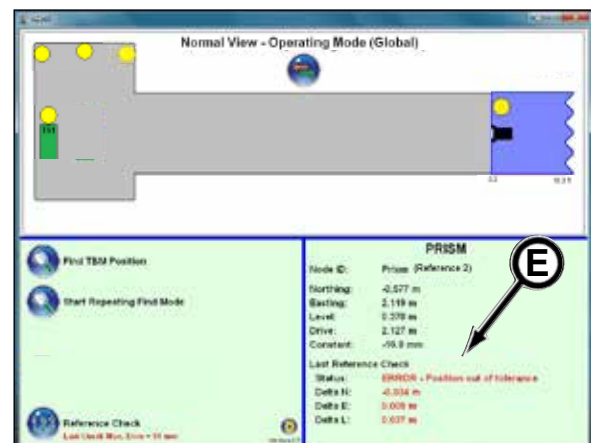
2. Once the Reference Check is complete, if an error is found, the "Last Check Max. error = th.ft" (C) will display in red and the prism(s) with the error will display with a red border (D).



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, perform another reference check. If error in reference check, the alignment must be reestablished by resurveying prism locations to be sure the shaft station is in proper alignment with the surveying marks. Then the shaft station will have to be realigned.

3. When a reference check error occurs, perform another reference check. If error continues, the alignment must be reestablished by resurveying prism locations to be sure the shaft station is in proper alignment with the surveying marks. Then the shaft station must be realigned.

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

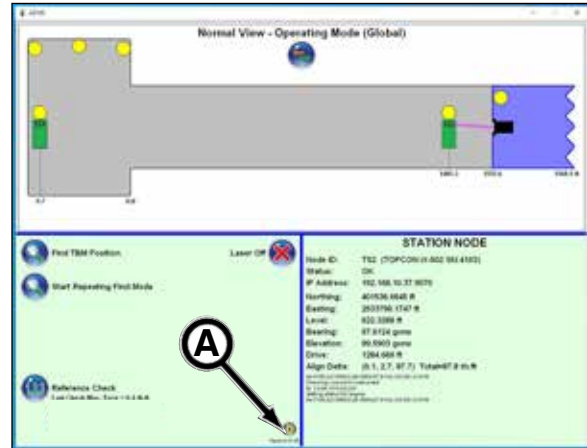


AUTO PRISM ALIGNMENT

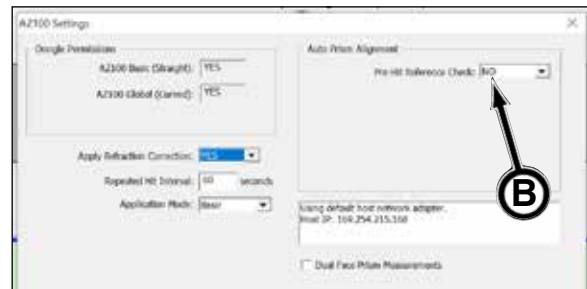
Using Auto Prism Alignment is used when jacking loads cause shaft movement. Auto Prism Alignment provides more consistent laser position at longer distances.

In most cases, the reference check is acceptable for achieving a successful tunnel. The auto prism alignment is an additional check or verification for extra long tunnel success.

1. In Operating Mode, click program Version icon (A).

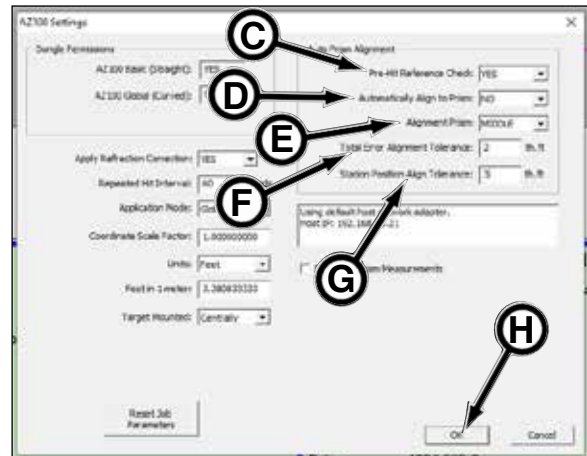


2. The AZ100 Settings window appears.



3. The Auto Prism Alignment Pre-Hit Reference Check defaults to NO (B).

4. When changing Pre-Hit Reference Check to Yes (C), the auto prism alignment window will expand to additional alignment data fields.



5. Automatically Align to Prisms (D) defaults to NO.

- By leaving the field to NO, a Reference Check Exceeds Tolerance window will appear if prisms are out of tolerance. See more details in step 12C.

- If changing to YES, the prism alignment and reference check will begin automatically.

6. Alignment Prism (E) defaults to MIDDLE. Options for this field are LEFT, MIDDLE and RIGHT. It is recommended to use the MIDDLE prism.

7. Total Error Alignment Tolerance (F) and Station Position Align Tolerance (G) fields default to zero.

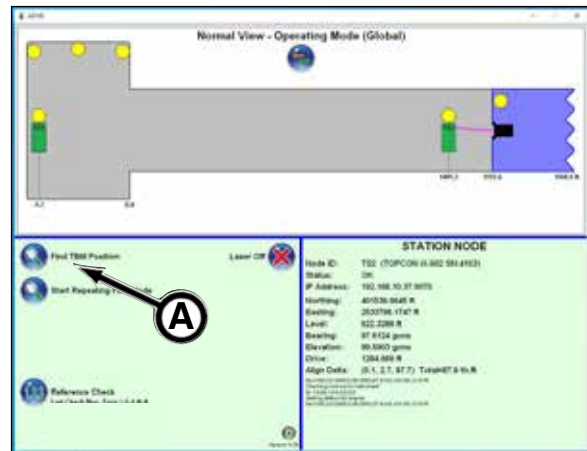
These values are determined by an Akkerman technician. These values are dependent upon the physical job parameters consisting of prism layout, shaft station location and third party survey data.

8. Click OK (H).

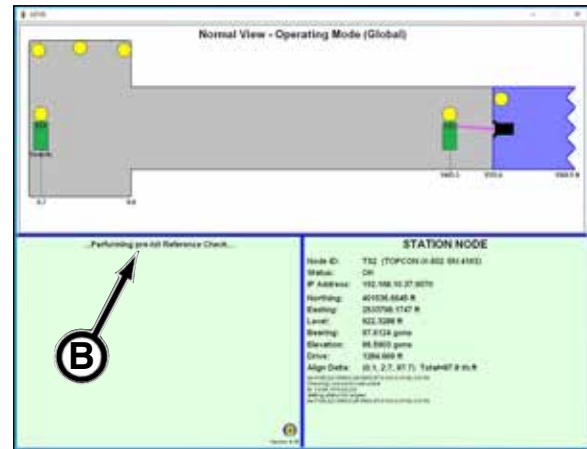
(continued on next page)

9. The Operating Mode window will reappear.

10. Click Find TBM Position (A).



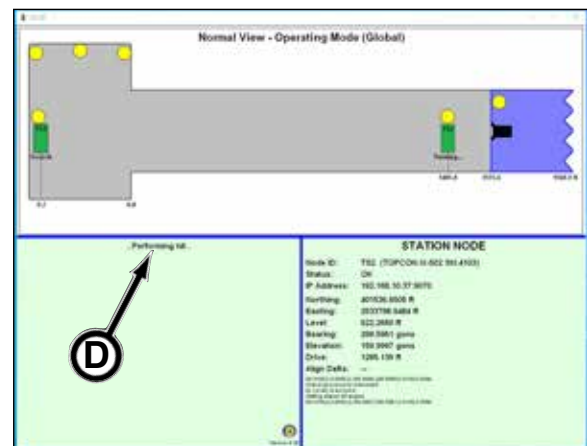
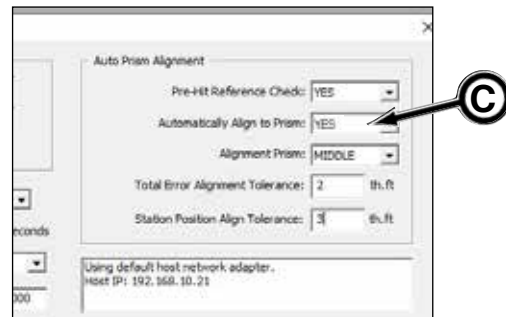
11. In control pane, the Performing pre-hit Reference Check (B) starts. This may take several seconds.



12. IF:

A. Automatically Align to Prism is set to YES (C) in the Auto Prism Alignment window, the Find TBM process will begin Performing hit (D).

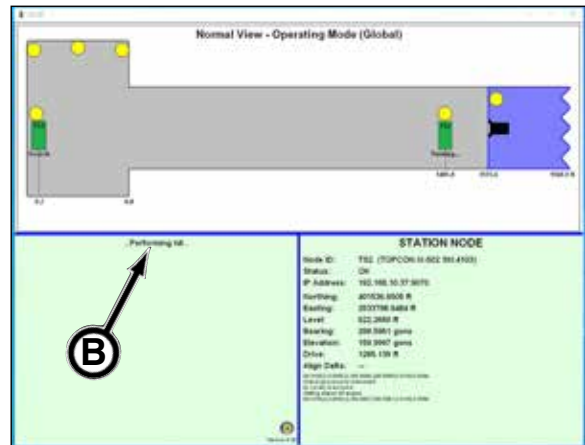
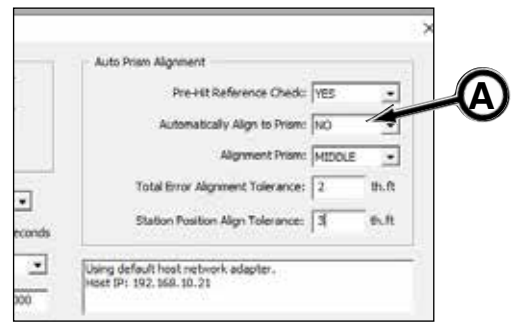
- the two total stations (TS1 [Shaft Station], TS2 [Pipe Station]) will work together to establish the alignment between the two stations, then the TS2 will rotate to find the TBM position.



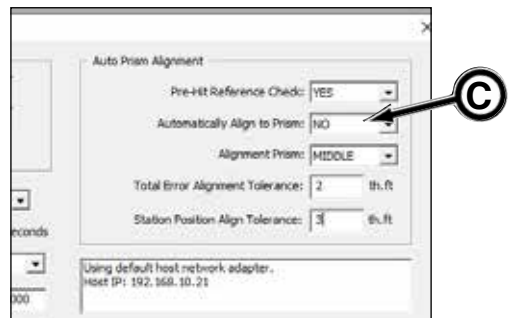
(continued on next page)

B. Automatically Align to Prism is set to NO (A), and the prism is within tolerance, the Find TBM process will begin Performing hit (B).

- the two total stations (TS1 [Shaft Station], TS2 [Pipe Station]) will work together to establish the alignment between the two stations, then the TS2 will rotate to find the TBM position.



C. Automatically Align to Prism is set to NO (C), and the prism is out of tolerance, the Reference Check Exceeds Tolerance window appears.



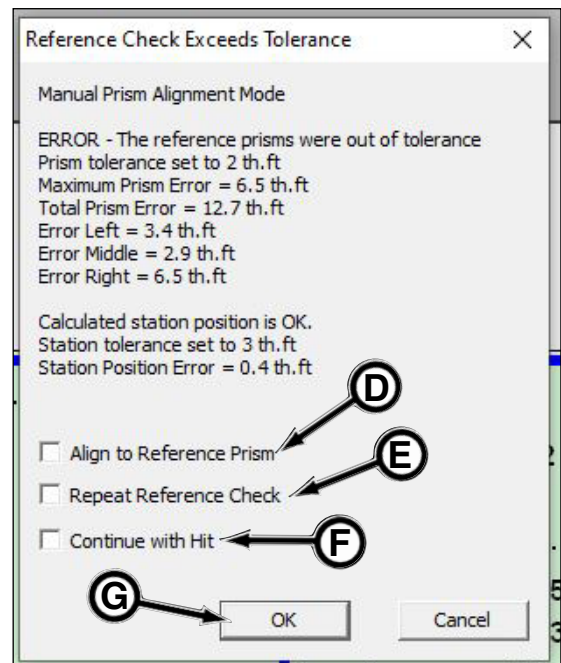
The window summarizes the prism data and the tolerances that were set in Auto Prism Alignment window.

There are three options:

- Align to Reference Prism (D)
This aligns the system to the Align Prism that is selected in the Auto Prism Alignment window.
- Repeat Reference Check (E)
This repeats the reference check, checking the reference points of the three prisms.
- Select this option if something out of the ordinary happened, such as thrusting while performing this check since doing so will cause errors.
- Continue with Hit (F)
This will ignore the prism errors and continue with the Find TBM process.

13. After selecting option, check OK (G).

(continued on next page)

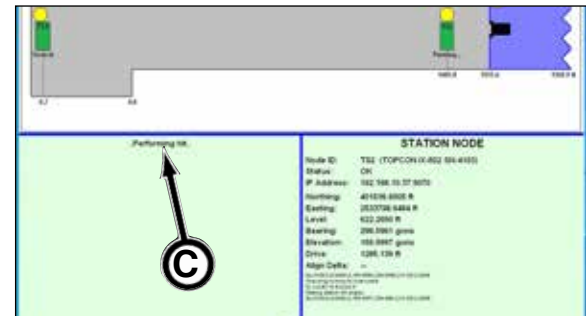
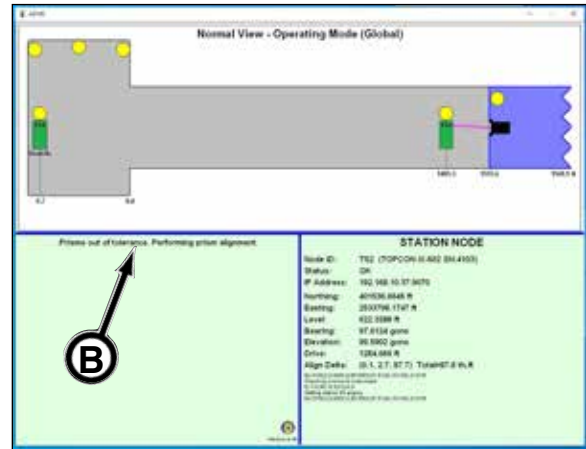
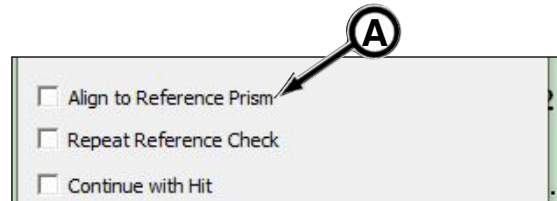


14. If you selected:

- Align to Reference Prism (A)

In the control pane, the Prisms out of tolerance. Performing prism alignment message (B) appears.

After alignment is complete, the Find TBM Position process (C) begins.

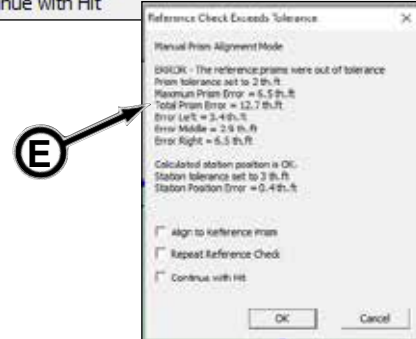
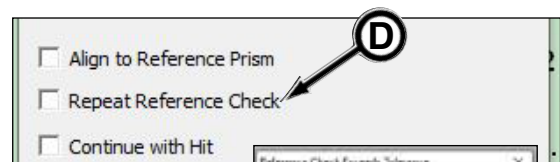


- Repeat Reference Check (D)

This option immediately repeats another reference check

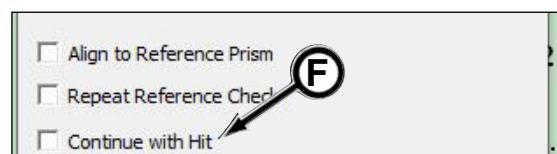
If errors still occur, the Reference Check Exceeds Tolerance window (E) will appear.

If the check is in tolerance, the Find TBM Position process begins.



- Continue with Hit (F)

This will ignore the prism errors and continue with the Find TBM process.



(continued on next page)

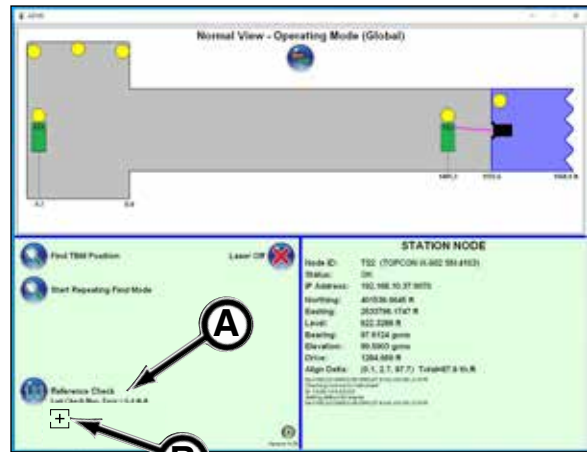
15. Once alignment is OK, the Operating Mode window will appear.

- If no realignment occurred, the Reference Check (A) will be shown in the bottom left area of the control pane.

- If there is additional information, a (B) will be displayed. Click the + to expand the reference check prism error information. This information is used for troubleshooting.

NOTICE

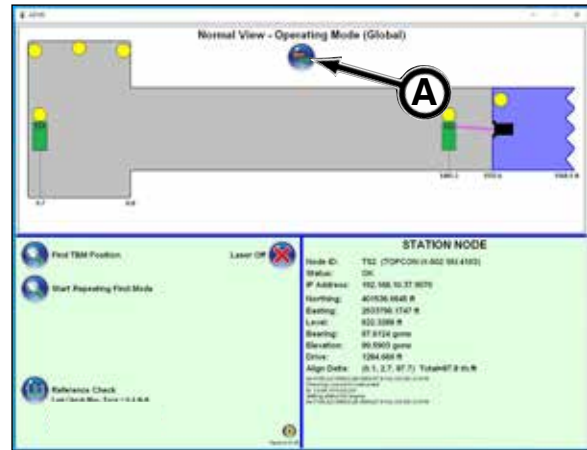
If auto align is performed, the reference check information will not be displayed.



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.

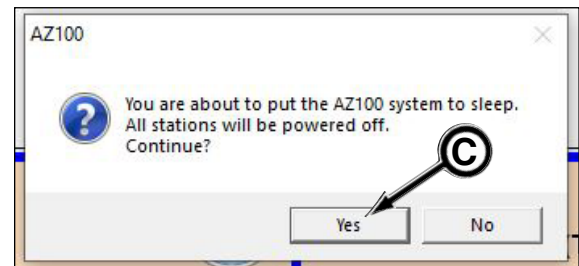
1. In Operating Mode, click switch button (A) to change view from Normal View - Operating Mode to Normal View - Setup Mode screen.



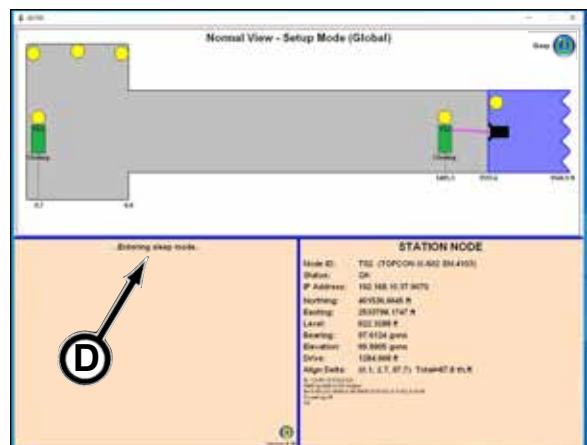
2. Click Sleep button (B).



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

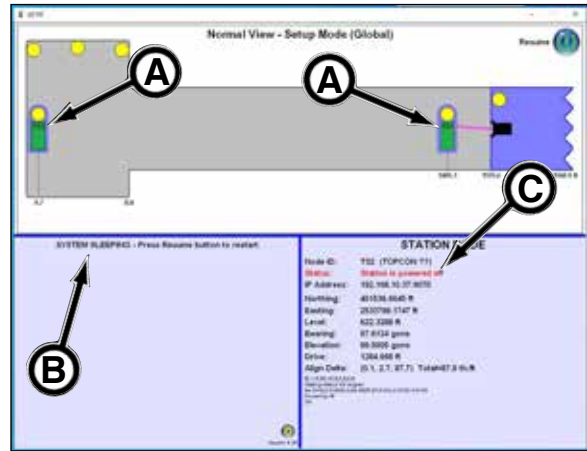


4. In the control pane, “..Entering sleep mode..” (D) appears. This may take several seconds.



(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.

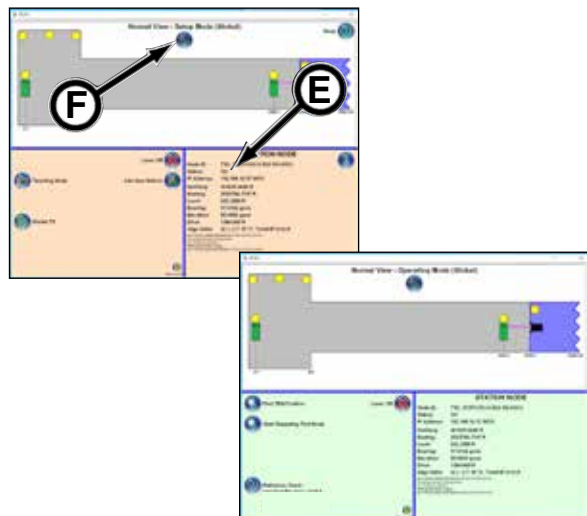
⚠ WARNING BEFORE reactivating power, be sure to communicate to all personnel that the electric and hydraulic power will resume shortly. Verification must be received from equipment operators that it is acceptable to restart. Failure to do so may cause serious injury or death from unintended equipment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

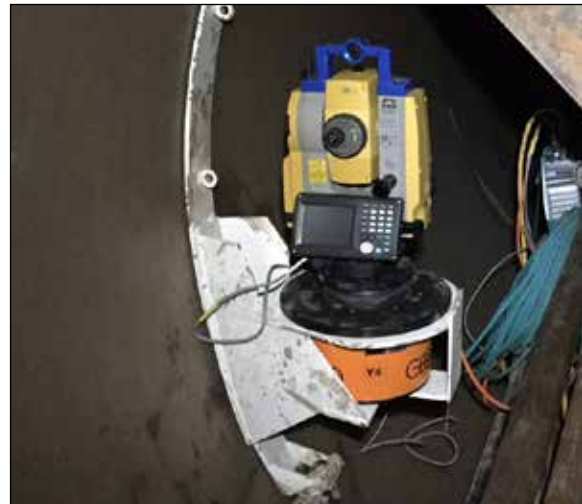


REINSTALLING TOTAL STATIONS IN TUNNEL

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:

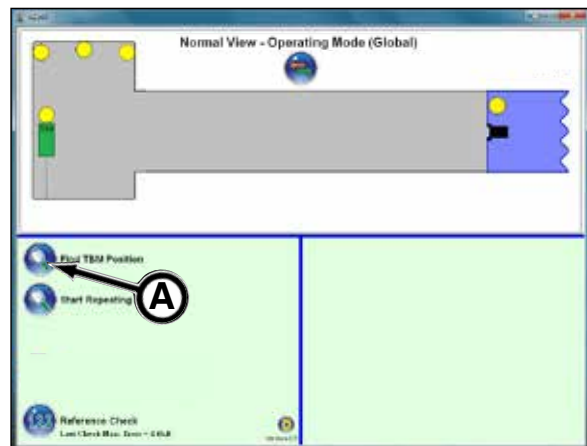
1. If the SNU was removed, CAREFULLY reinstall and connect all cables to the SNU bulkhead connections and components.
2. CAREFULLY replace the total station to the tribrach. Secure with clamp and tribrach locking screw.
3. With all connections in place, power up the SNU.
4. Perform the tilt offset check 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).



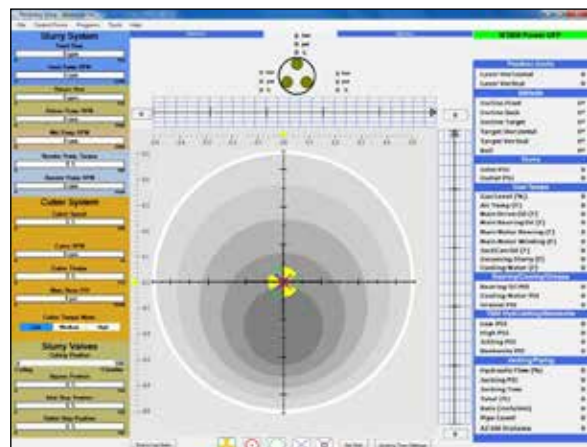
If the locations are correct, continue to step 6.

If locations are not correct, perform another reference check. If error continues, the alignment must be reestablished by resurveying prism locations to be sure the shaft station is in proper alignment with the surveying marks. Then the shaft station must be realigned.

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, the alignment must be resurveyed.



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.



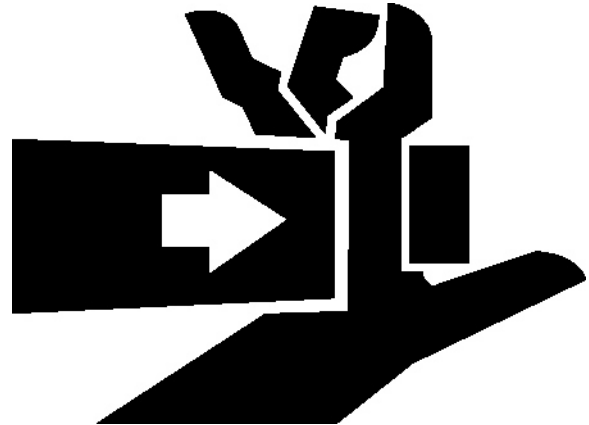
AVOID PINCH POINTS

⚠ 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

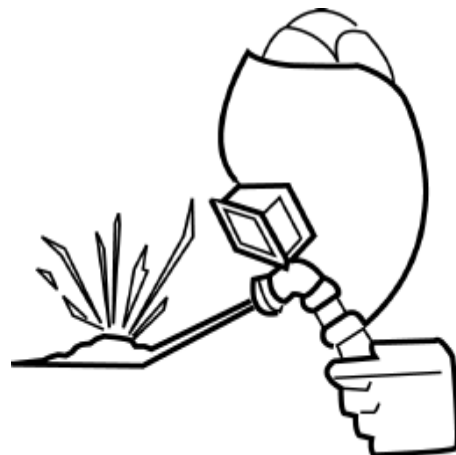
⚠ WARNING Unauthorized welding can cause structural failure and guidance system damage.

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

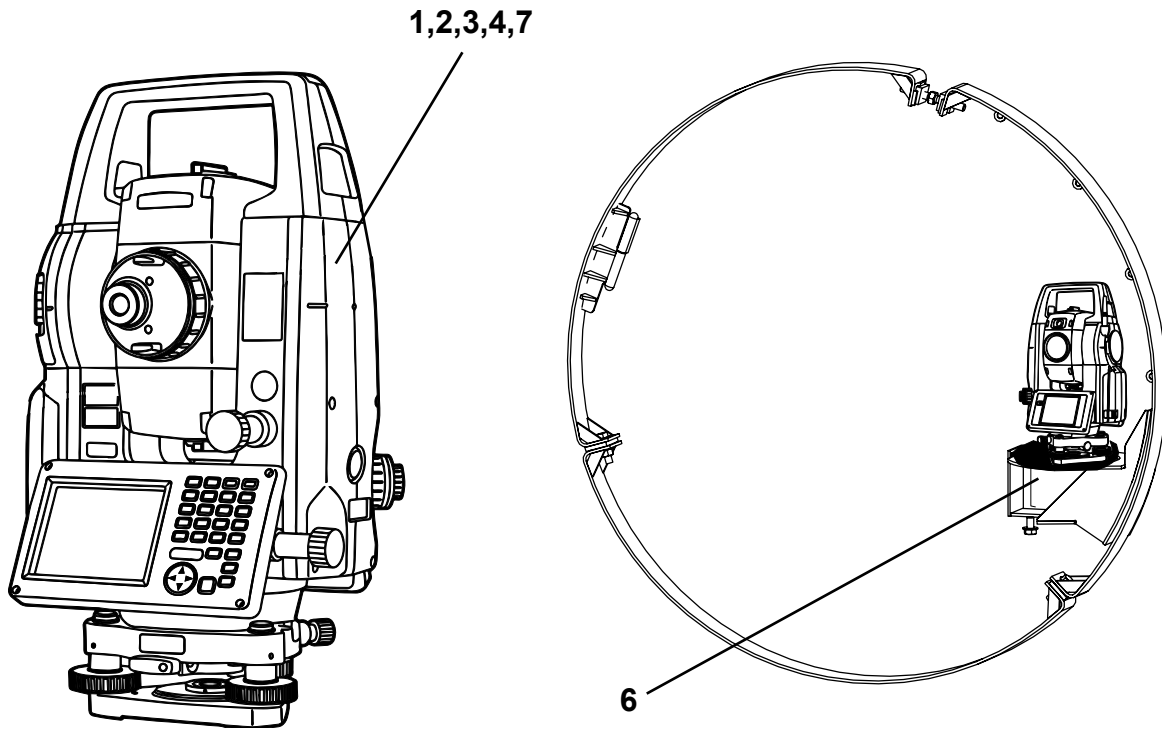
WELDING ON STRUCTURE

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 Operation Section.
2.	Total Station	Collimation	Refer to Checking Collimation in Operation Section.

DAILY OR EVERY 10 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REFERENCE
3.	Total Station	Tilt Offset	Refer to Checking Tilt Offset in Operation Section.
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

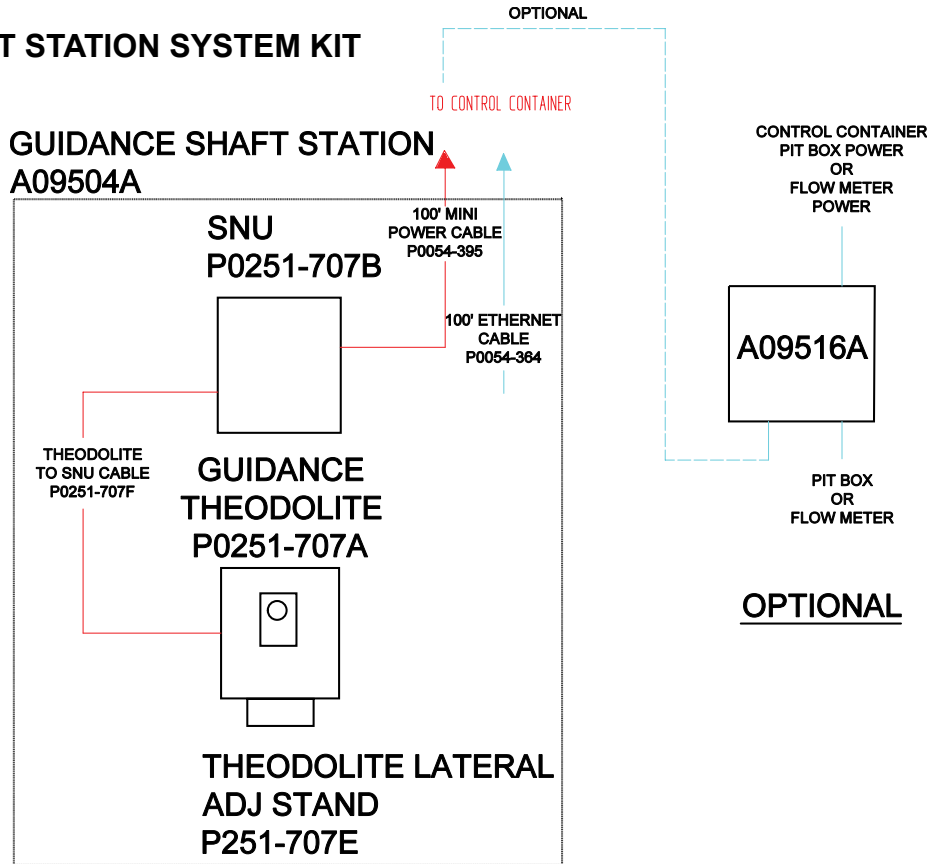
Problem	Cause	Solution
Shaft Station does not power up.	Power cable not installed from control container to SNU.	Connect power cable.
Pipe station does not power up.	Power cable not installed from front section box to SNU.	Connect power cable.
	Front section box is offline.	Power front section box.
Error: No prism found.	TBM prism not found.	Repeat Finding TBM Position. May require tunnel alignment.
	Reference prism not found.	Configure reference prisms.
	Line of sight is blocked.	Remove obstruction between shaft station and prism.
Error: Position Out of Tolerance.	Reference prism or shaft station moved.	Resurvey shaft prisms and realign shaft station to survey marks.
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

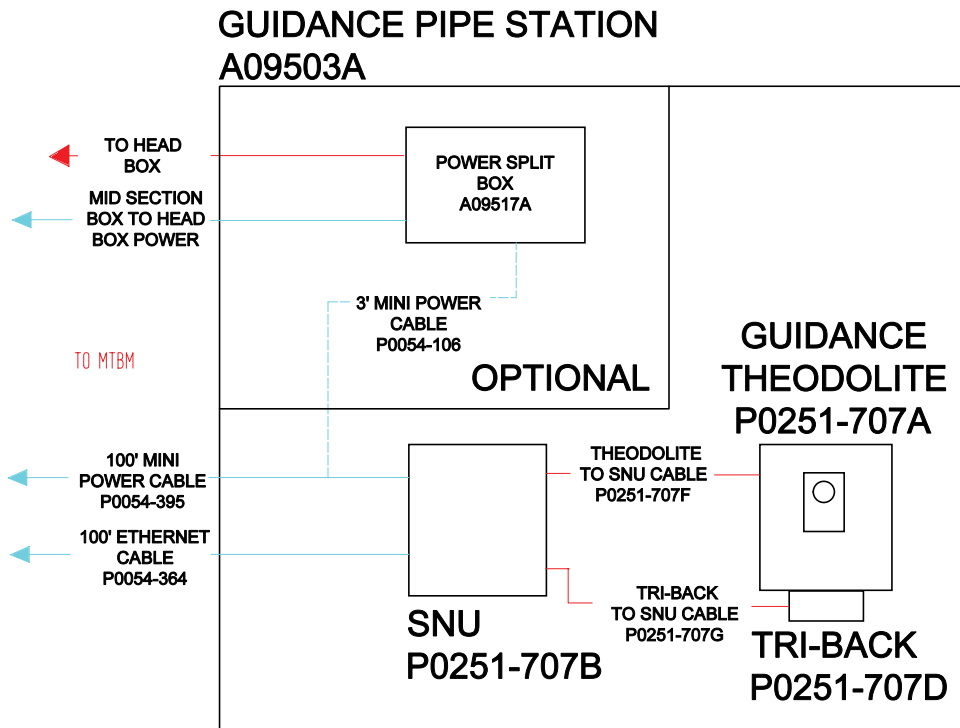
Error Message	Cause	Solution
Relevel error.	Total station bumped or other means to cause total station to be out of level.	Unplug total station from SNU. Re level total station then reconnect SNU to total station.
Bad condition.	The air quality is poor.	Ventilate tunnel and resight target.
Motor error 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 5-22, 5-31
Add new station button 5-31
Address bar 5-19
Adjustment knobs 5-11
Air analyzer 1-3
Align 5-29
Alignment 5-30, 5-31, 5-36, 5-45
Align station to selected reference prism button.. 5-25
Align to reference prism 5-39, 5-40
Alignment prism 5-37
All job settings have been deleted Window ... 5-33
Angle measurement 8-1, 8-2
Application mode 5-20
Apply refraction correction 5-20
Are you sure?... Window 5-33
Arm mount 5-4
Arrow button 5-24
Arrow buttons 5-24
Assembling the pipe station 5-10
Assembling the shaft station (launch shaft) 5-4
Auto prism alignment 5-21, 5-37
Automatically align to prisms 5-37, 5-38, 5-39
AZ100 basic (straight) 5-20
AZ100 dongle 5-20
AZ100.exe icon 5-20, 5-33
AZ100 global (curved) 5-20
AZ100 message window 5-25, 5-27
AZ100 settings 5-20
AZ100 settings window 5-33
AZ100 shaft prism guidelines 5-3
AZ100 software 4-1, 7-1
AZ100 software program 5-33
AZ100 software screens 3-4
AZ100 total guidance system i, 5-2

B

Bad condition 7-2
Before long drive or at least every twelve months...6-2
Border, prism red 5-25
Border, red 5-20, 5-22
Border tbn, red 5-29
Bubble 5-11
Bubble level 5-9
Bulkhead protective covers 5-44
Button, add new station 5-31
Button, align station to selected reference prism. 5-25
Button, arrow 5-24
Button, exit rotate mode 5-24
Button, find tbn position 5-29, 5-32, 5-34
Button, information 5-26, 5-28, 5-31
Button, normal mode 5-26
Button, red x 5-24
Button, reference check 5-30
Button, reload DTA 5-28
Button, rotate TS 5-24

B (Continued)

Buttons, arrow 5-24
Button, switch 5-22, 5-29
Button, switch mode 5-27
Button, teaching mode 5-24
Button, teach prism position 5-27

C

Calculated station position, newly 5-27
Calibration 6-2
C drive 5-18, 5-19
Centerline of the pipeline 5-4
Certified surveyor 5-24
Charts, maintenance 6-2
Checking collimation 5-16
Checking total station tilt offset 5-11
Check, tilt offset 5-11
Circular level 5-9, 5-11, 5-12
Clothing, protective 1-1
Collimation 5-17, 5-20, 5-30, 6-2
Collimation check 5-9
Collimation, checking 5-16
Collimation/result window 5-17
Collimator 5-30
Collimator, sighting 5-11, 5-16, 5-30
Config 5-12, 5-16, 5-29
Config folder 5-19
Configure 5-31
Configured, tunnel 5-22
Configure prism window 5-24
Configure reference prisms 7-1
Configure total station -TS1 window 5-26
Configure tunnel parameters window 5-28
Connection established but no reply 7-1
Connection established but no reply, status: ... 5-23
Constant value, reference prism 5-24
Constants, prism 5-3
Contents iii
Control container 5-23
Control pane 5-20
Controls & instruments 4-1
Coordinate data, planned tunnel 5-18
Coordinate scale factor 5-20
Correction angle 5-15
Covers, bulkhead protective 5-44
Current spot 5-45
Curve tunnels 5-32

D

Daily or every 10 hours of operation 6-2
Daily shut down 5-44
Data_projectname.txt 5-18
Data.txt 5-18
Data.txt file 5-18
Designed tunnel axis 5-18
Distance measurement 5-29, 5-34, 8-1, 8-2

D (Continued)

Distance meter	4-2
Dog	5-30, 5-34
Dongle	5-33
Dongle, AZ100	5-20
DTA button, reload	5-28
DTA file	5-28
DTA, loading drive	5-18
DTA, old project	5-18
Dual face measurement	5-21

E

Easting	5-22, 5-24, 5-26
Edit button	5-24
Electronic bubble (tilt) window	5-9
Electronic display	5-12
Electronic level window	5-12
Electronic theodolite	4-2
Entering sleep mode	5-42
Error message bad condition	7-2
Error message motor error EXXX	7-2
Error message relevel error	7-2
Error message temp range out	7-2
Error message tilt over range !!	7-2
Error message time out !!	7-2
Error: no prism found	7-1
Error: position out of tolerance	7-1
Error - position out of tolerance	5-35
Errors, reference check	5-27, 5-30, 5-35
Esc key	5-12, 5-17
Ethernet link cable	4-2
Ethernet repeater box, terminology	3-6
Every twelve months	6-2
Exit rotate mode button	5-24
Expandable pipe band	5-10
Exposure, laser light	1-2
Extension hidden	5-18
Extensions shown	5-18
Eyepiece, telescope	5-14, 5-17

F

F2	5-14
Face 2	5-17
Feet in meters	5-20
Finding tbm position	5-34
Find tbm position	5-30, 5-45
Find tbm position button	5-29, 5-32, 5-34

G

General information	5-20
Global.Dta	5-18
Global_projectname	5-18
Graphic pane	5-31
Guidance station kits	7-3
Guidance system software	8-1
Guide light	5-11, 5-16, 5-30
Guidelines, operating	5-1

H

Hidden, extension	5-18
Hitlog.Dat	5-18
Hitlog_projectname.Dat	5-18
Hydraulic oil/fluids under pressure	1-2

I

Information button	5-23, 5-26, 5-28, 5-31
Information pane	5-20
Inst.Cons	5-13, 5-16
Instruments & controls	4-1
Interface box	4-2
Introduction	i
IP address	5-21, 5-22, 5-23, 7-1

J

Job parameters	5-21, 5-33
----------------------	------------

K

Kit, pipe station system	7-3
Kit, shaft station system	7-3

L

Laser beam	5-4
Laser light exposure, avoid	1-2
Laser positioning	5-10
Laser position marker	5-10, 5-44
Laser positions	5-31, 5-44, 5-45
Last check max. Error =	5-27, 5-30, 5-36
Last reference check	5-27
Launch shaft	5-20
Level	5-22, 5-24, 5-26
Leveling foot screws, tribrach	5-12
Line of sight	5-4, 5-6, 5-30, 5-36
Loading drive DTA	5-18
Lockout tagout power	1-2, 6-1

M

Maintenance, before long drive or at least every twelve months..	6-2
Maintenance charts	6-2
Maintenance, daily or every 10 hours of operation	6-2
every twelve months	6-2
periodic	6-1
practice safe	1-3
prior to job	6-2
whenever subjected to strong vibration or bumped..	68
Manufacturer	5-22, 5-31
Manufacturer, prism	5-24
Marker, laser position	5-10, 5-44
Measurement, distance	5-29, 5-34
Microtunneling control target screen	5-44
Motor error EXXX	7-2
Mount	5-4
Mount, pipe station	5-10
Mount, side	5-10

M (Continued)

Moving parts	6-1
Mtbn_companyname	5-19
Mtbn length	5-29

N

Name	5-28
Newly calculated station position	5-27
Normal mode button	5-26
Normal view - operating mode 3-4, 5-20, 5-22, 5-27, 5-29, 5-32, 5-33, 5-34	
Normal view - setup mode 3-4, 5-22, 5-24, 5-26, 5-31	
Northing	5-22, 5-24, 5-26

O

Offset, prism drive	5-29
Old project DTA	5-18
Old projects folder	5-18
Operating guidelines	5-1
Operation	5-1
Operator's manual, read	1-1
Orange border, TS1 with	5-23
Osha approved protective clothing	1-1
Overview	5-2
Oxygen deficiency	1-3

P

Pane, control	5-20
Pane, graphic	5-31
Pane, information	5-20
Pane, tunnel view	5-20, 5-34
Parameters, job	5-33
Performing reference checks	5-36, 5-39
Periodic maintenance	6-1
Pinch points	6-1
Pipe band	4-1
Pipe band, expandable	5-10
Pipe band tensioner bolt	5-10
Pipe station	4-1, 5-2, 5-30
Pipe station, assembling the	5-10
Pipe station does not power up	7-1
Pipe station mount	5-10
Pipe stations	5-33
Pipe station system kit	7-3
Planned tunnel coordinate data	5-18
Position finding sequence	5-32
Power button	5-9, 5-11
Power cable	7-1
Power, lockout tagout	1-2, 6-1
Power split box	4-3, 5-4, 5-10
Power split box, terminology	3-5
Practice safe maintenance	1-3
Pre-hit reference check	5-37
Preparing the shaft station	5-9
Previous tunneling project	5-33
Prior to job & whenever subjected to strong vibration or bumped	6-2

P (Continued)

Prism	4-1, 4-2, 5-23, 5-24, 5-25, 5-27
Prism constant value, reference	5-24
Prism constants	5-3
Prism data	5-24
Prism drive offset	5-29
Prism location	5-24
Prism manufacturer	5-24
Prism node	5-3
Prism positions	5-27
Prism, red border	5-25, 5-27, 5-36
Prism, reference	4-2, 5-25
Prisms	5-2, 5-4
Prisms, reference	5-27, 5-30, 5-36
Prism, TBM	5-29, 5-34
Prism, TBM target	5-34
Prism vertical offset	5-22, 5-31
Program files folder	5-19
Project data, tunneling	5-21
Protective clothing	1-1
Protective covers, bulkhead	5-13

R

Realign shaft station	7-1
Red border	5-20, 5-22
Red border prism	5-27, 5-36
Red border, prism	5-25
Red border shaft	5-24
Red border tbn	5-29
Red border, TS1 with	5-23
Red x button	5-24
Refchecklog.dat	5-18
Refchecklog_projectname.dat	5-18
Reference check	5-36
Reference check button	5-30
Reference check error	5-27
Reference check errors	5-30, 5-36
Reference check exceeds tolerance	5-37
Reference check failure	5-24
Reference check, last	5-27
Reference check, performing	5-38
Reference checks, performing	5-36
Reference point	5-17
Reference prism	4-2, 5-25
Reference prism constant value	5-24
Reference prisms	5-27, 5-30, 5-33, 5-36
Reinstalling total stations in tunnel	5-45
Relevel error	7-2
Reload DTA	5-28
Reload DTA button	5-28
Remove station	5-31
Repeat reference check	5-39, 5-40
Repeated hit interval	5-20
Reset	5-31
Reset job parameters	5-19, 5-33
Reset job parameters button	5-21
Resurveying prism locations	5-35

R (Continued)

Resurvey shaft prisms	7-1
Rotate mode button, exit	5-24
Rotate TS button	5-24

S

Safety	1-1
Safety decals	2-1
Safety information	1-1
Searching	5-29
Self leveling total station units	5-2
Self leveling tribrach	4-1, 5-10
Self-level tribrach	6-2
Settings, AZ100	5-20
Settings version icon	5-33
Setup using az100 software program, system	5-20
Shaft prism guidelines	5-3
Shaft, red border	5-24
Shaft station	4-1, 5-33
Shaft station, assembling the	5-18
Shaft station does not power up	7-1
Shaft station (launch shaft), assembling the	5-4
Shaft station, preparing the	5-9
Shaft station SNU	5-23
Shaft station SNU power/comm cable	5-23
Shaft station system kit	7-3
Shaft station to tunnel	5-28
Shut down, daily	5-44
Side mount	4-1, 5-10
Sighting collimator	5-11, 5-16, 5-30
Skid lock	5-30, 5-34
Sleep mode	5-42
Sliding guide	4-1, 5-4
SNU	5-4, 5-10, 5-31, 5-44, 5-45
SNU IP address	5-22, 5-31
SNU power and comm cables	5-23
SNU, shaft station	5-23
Software, AZ100	4-1
Sokkia® total station specifications	8-2
Sokkia® total station theodolite - shaft station....	3-2
Specifications	8-1
Specifications, Sokkia® total station	8-2
Specifications, Topcon® total station	8-1
Split box, power	3-5
Start repeating find mode	5-35
Station network unit (SNU)	4-2
Station network unit (SNU)	4-1
Station node status	5-31
Station position, newly calculated	5-27
Station position window	5-25
Status: connection established but no reply ...	5-23
Status text	5-29
Status: unable to establish a connection	5-23
Steady state	5-10
Surveying marks	5-4, 5-36
Surveyor, certified	5-24
Switch button	5-22, 5-29
Switch mode button	5-27
System setup using AZ100 software program.	5-20

T

Target glass to cutterhead	5-40
Target screen, microtunneling control	5-44
Tbm graphic	5-32
Tbm name	5-29
Tbm position	5-29, 5-32, 5-34
Tbm prism	5-29, 5-32, 5-34
Tbm prism position	5-34
Tbm, red border	5-29
Tbm target prism	5-34
Teaching mode button	5-24
Teach prism position button	5-27
Telescope	5-14
Telescope	8-1, 8-2
Telescope eyepiece	5-14, 5-17
Temp Rnge out	7-2
Tensioner bolt, pipe band	5-10
Terminology	3-1
Terminology - AZ100 software screens	3-4
Terminology - ethernet repeater box	3-6
Terminology - pipe station	3-3
Terminology - power split box	3-5
Test shaft & tunnel ventilation	1-3
TGS 100 target	5-2
This will reset all job related" Window	5-33
Tilt angle compensation	8-1, 8-2
Tilt angle compensation icon	5-9
Tilt offset	5-13
Tilt offset	5-20, 5-30, 6-2
Tilt offset check	5-9, 5-11, 5-15, 5-16, 6-2
Tilt offset, checking total station	5-11
Tilt offset compensation	5-20
Tilt offset compensation range	5-9
Tilt over range !!	7-2
Time out !!	7-2
Tilt_ofs	5-12
Topcon®/Sokkia® total station troubleshooting ..	7-2
Topcon® total station	8-1
Topcon® total station specifications	8-1
Topcon® total station theodolite - shaft station ..	3-1
Total error alignment	5-37
Total station	4-1, 4-2, 5-1, 5-9, 5-10, 5-11
Total station base	5-44, 5-45
Total stations in tunnel, reinstalling	5-45
Total station tilt offset, checking	5-11
Tribrach	4-1, 5-4, 5-9, 5-11, 5-44, 5-45
Tribrach clamp	5-1
Tribrach leveling foot screws	5-12
Tribrach, self-level	5-2
Tribrach, self leveling	5-10
Troubleshooting	7-1
Troubleshooting, AZ100 software	7-1
Troubleshooting - guidance station kits	7-3
Troubleshooting - Topcon®/sokkia® total station ...	7-2
TS1 .. 5-23, 5-24, 5-25, 5-26, 5-29, 5-30, 5-31, 5-34	
TS1 icon	5-22
TS1 icon red	5-23
TS1 with orange border	5-23

T (Continued)

TS1 with orange border status	7-1
TS1 with red border	5-23
TS1 with red border status	7-1
TS2	5-31, 5-32, 5-34
TS button, rotate	5-24
Tunnel	5-20
Tunnel alignment	5-33, 7-1
Tunnel alignment mode	3-4
Tunnel alignment mode window	5-24, 5-25, 5-26, 5-27
Tunnel area	5-28
Tunnel axis	5-4
Tunnel boring Machine	5-20
Tunnel configured	5-22
Tunnel coordinate data, planned	5-18
Tunnel diameter	5-28
Tunnel distance measurement does not update ..	7-1
Tunnel eye	5-28
Tunneling project data	5-21
Tunnel layout	5-20
Tunnel project	5-21
Tunnel ventilation	5-10
Tunnel view pane	5-20, 5-34
Turning	5-29

U

Unable to establish a connection, status:	5-23
Unable to establish connection	7-1
Unauthorized welding	1-4, 6-1
Unit	5-20
Using sleep mode	5-42

V

Ventilation, test shaft & tunnel	1-3
Version icon, settings	5-33

W

Waiting	5-29
Warranty	9-1
Welding	6-1
Welding on structure	6-1
Window, all job settings have been deleted	5-33
Window, are you sure?...	5-33
Window, AZ100 message	5-25, 5-27
Window, collimation/result	5-17
Window, configure prism	5-24
Window, configure total station -TS1	5-26
Window, configure tunnel parameters	5-28
Window, normal view - operating mode	5-27
Window, normal view - setup mode	5-26
Window, station position	5-25
Window, this will reset all job related	5-33
Window, tunnel alignment mode
.....	5-24, 4-25, 4-26, 4-27

X

X button, red	5-21
Xydt.a.dta	5-19
Xydt.a.projectname	5-19

NOTES