

Suggested Template for Quality Control Program for Ground Support

Item	Description	Department Responsible	Monitoring schedule, communication and record keeping	Acceptance criteria	Remedial measures required if acceptance criteria are not met
A. Procurement specifications					
1. Specifications for ground support products and accessories	All ground support products and accessories must meet relevant ASTM/CSA standards.	Ground Control and Purchasing Departments.	<p>Ground Control Department conducts an annual review of specifications for ground support products and accessories.</p> <p>The Purchasing Department requests a manufacturer's certification to ensure that ground support products and accessories are manufactured and tested in accordance with the relevant ASTM/CSA standards.</p>	<p>Specifications for ground support products and accessories meet relevant ASTM/CSA standards.</p> <p>Ground support products and accessories delivered to mine site meet relevant ASTM/CSA standards.</p>	<p>Changes, revisions or additions reviewed and approved by the Ground Control Department.</p> <p>If necessary, seek alternate suppliers.</p>
2. Supplier Certification	All suppliers of ground support products and accessories should hold ISO 9001-2008 certification.	Purchasing Department.	Annual audit by Purchasing Department.	Suppliers hold current ISO 9001-2008 certification.	If supplier does not hold current ISO 9001-2008 certification, consideration should be given to identifying another supplier who holds current ISO 9001-2008 certification.

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B. Standard for receiving, storage and handling					
1. Quality control of newly received ground support products	All ground support products and accessories should be checked for overall condition, along with dimensions, threads, expiry date of resin cartridges, weld quality on Welded Wire Mesh (WWM), etc.	Ground Control Department	Products checked upon delivery. Records kept by Ground Control Department.	Conformance with procurement specifications and ASTM/CSA Standards	Defective products are returned to the supplier
2. Handling and storage on surface and underground	All ground support products should be handled and stored as per the manufacturers' specifications and mining industry best practices.	Ground Control and Operations Departments	Practices audited as per frequency established by Ground Control and Operations Departments. Records maintained by Ground Control Department.	Conformance with manufacturer's specifications and safe practices.	Provide training and/or other remedial measures (improved storage racks, indoor storage of ground support products, etc.)

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C. Standard Operating Procedures (SOPs) and training					
1. SOPs for ground support installation	Prepare and update SOPs to reflect current best practices for installation of all ground support products in use at the mine.	Training Department responsible for developing/updating SOPs. Ground Control and Operations Departments responsible for auditing SOPs. Joint Health and Safety Committee (JHSC) reviews SOPs.	SOPs updated and audited annually, or more frequently if new ground support systems are introduced, or other conditions have changed (e.g. rock mass conditions, installation equipment, etc.).	Current and comprehensive SOPs for the installation of all ground support products should be readily available to all concern employees for review.	Training Department to seek input from Ground Control and Operations Departments, and JHSC in developing acceptable ground support installation SOPs.
2. Initial and refresher training on SOPs for ground control procedures, ground support installation, ground support standards, and quality control program for ground support	All new concerned employees to receive initial training on SOPs for ground control procedures, ground support installation, ground support standards, and quality control program. Refresher training to be provided annually or as required by the mining operation.	Training, Ground Control, and Operations Departments, as determined.	Training records kept by the Training Department.	All concerned employees have received the required initial and refresher training.	Provide additional training to workers as required.

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D. Monitoring of ground support installation and post-installation					
1. Maintenance and calibration of installation equipment	All equipment used to install ground support should be calibrated regularly and checked for proper operation, e.g. rotation speed of mechanized bolters, inflation pressure provided by Swellex pumps, etc.	Maintenance and Ground Control Departments.	Frequency established by Ground Control and Maintenance Departments, following manufacturer's recommendations. Records are maintained by the Ground Control Department.	Manufacturer's specifications are met.	Repair installation equipment as required.
2. Job observations by supervisors of ground support installation	Using checklists developed by the Ground Control and Operations Departments, underground supervisors conduct and document regular job observations of crews installing ground support, and provide coaching to workers as required.	Operations and Ground Control Departments.	Operations and Ground Control Department establish required frequency. Completed job observation forms are audited by Operations and Ground Control Departments; records are maintained for a specified period.	The required frequency of job observations is followed, forms are completed accurately, and there is adequate follow-up to observations. All crews are aware of proper installation procedures.	Mine management to require supervisors to conduct and document job observations of ground support installation. Training Department to provide additional training to installation crews and to review SOP's as required.

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3. Ground support evaluations by Ground Control Department	<p>Ground Control Department conducts regular evaluations of workplaces for rock mass conditions, initial ground support installation quality, present condition of ground support, performance and any action required.</p> <p>A checklist/matrix may be used to evaluate ground support installation quality and current condition, ground conditions, and the risk/ exposure. Rehab categories/priorities are assigned following the inspection.</p>	<p>Ground Control Department.</p>	<p>Active headings and other areas are inspected on an established frequency.</p> <p>Ground Control Department communicates findings to the Operations Department, and follows up on recommendations.</p> <p>Ground Control Department maintains permanent records.</p>	<p>The required frequency of ground support evaluations is followed, and forms are completed accurately.</p> <p>Ground support systems adequate for ground conditions encountered.</p>	<p>Ensure established schedule is followed.</p> <p>Recondition areas as required, provide additional training and/or re-evaluate ground support standards if needed.</p>

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4. Reporting of non-conformance issues	<p>Ground support issues are reported through 5 pt. Safety systems cards, internal Ground Condition/Occurrence Reports, logbooks, inspections, audits, Unusual Occurrence Reports for Groundfall/Rockburst, etc.</p> <p>Suppliers are notified if investigation or testing is required.</p>	<p>Crews report issues verbally or through 5 pt. Safety system cards. Supervisors complete Ground Condition/Occurrence Reports and logbooks. Ground Control Department completes Unusual Occurrence Reports for Groundfall/Rockburst. Ground Control Department is responsible for follow-up.</p>	<p>Ground Control Department:</p> <ul style="list-style-type: none"> • evaluates and follows up on reported issues • communicates findings to all concerned. • maintains permanent records of pertinent information 	<p>All records of non-conformance issues are up to date and proper follow-up has been conducted.</p>	<p>Provide training to ensure timely reporting of non-conformance issues.</p> <p>Conduct internal or external auditing of records to ensure timely and thorough follow-up of issues.</p>
5. Evaluation and approval of new ground support products and accessories	<p>All new ground support products and accessories are evaluated and approved following an established process before they are installed underground.</p>	<p>Ground Control and Operations Departments</p> <p>Suppliers and outside organizations provide assistance as required.</p>	<p>Ground Control Department:</p> <ul style="list-style-type: none"> • follows established process • communicates findings to all concerned. • maintains permanent records of pertinent information 	<p>As established by Ground Control and Operations Departments.</p>	<p>Work with suppliers or identify alternate products or suppliers.</p>

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6. Instrumentation for post-installation monitoring and evaluation	Instruments are installed to determine if the ground support is appropriate for the ground conditions encountered. This may include Multi-Point Borehole Extensometers (MPBX), Smart Cables, GMMs, contractometers, etc.	Ground Control Department determines the locations and types of instruments, and ensures the instruments are installed and monitored.	<p>Ground Control Department determines frequency of data collection and analysis. Operations Department may assist with data collection as required.</p> <p>Ground Control Department provides timely analysis of data and maintains permanent records.</p>	Instruments provide useful information to assist in the evaluation of ground support performance.	<p>If instruments are not installed as specified, remedy situation.</p> <p>If installed instruments are not providing useful information, investigate alternate methods of monitoring.</p>

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E. Ground support testing and evaluation					
1. Mechanical bolts	Regular torque and pull tests are conducted to assess installation quality and bolt performance.	<p>Ground Control Department and/or Operations Departments conduct torque tests.</p> <p>Ground Control Department and/or ground support supplier conduct pull tests.</p>	<p>Ground Control Department:</p> <ul style="list-style-type: none"> • establishes test schedule • analyses data, with possible assistance from supplier • communicates results to all concerned personnel, including JHSC • maintains permanent records. 	<p>Established by Ground Control Department.</p> <p>Generally accepted anchor slips are 0.028 in./1000 lb. or less in hard rock mines.</p>	<p>Torque tests - investigate reasons for low or high torque readings; correct anomalous situations.</p> <p>Pull tests - conduct pull tests on alternate rockbolt shells.</p>

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2. Resin rebar (cartridges or resin injection)	<p>Regular pull tests are conducted to confirm to assess installation quality and bolt performance.</p> <p>Pull tests should be conducted to determine the resin bond strength (tons/ft).</p>	<p>Ground Control Department and/or ground support supplier conduct pull tests.</p>	<p>Ground Control Department:</p> <ul style="list-style-type: none"> • establishes test schedule • analyses data, with possible assistance from supplier • communicates results to all concerned personnel, including JHSC • maintains permanent records. 	<p>Established by Ground Control Department.</p> <p>A generally accepted target resin bond strength is 1 ton/inch.</p>	<p>Investigate causes of poor pull test performance (e.g. poor resin quality or expired resin, hole diameter, improper spin or hold times, etc.); remedy situation.</p>
3. Friction stabilizers (e.g. Split Sets)	<p>Regular pull tests are conducted to confirm to assess installation quality and bolt performance.</p> <p>Driving time of the bolt should be checked.</p>	<p>Ground Control Department and/or ground support supplier conduct pull tests.</p>	<p>Ground Control Department:</p> <ul style="list-style-type: none"> • establishes test schedule • analyses data, with possible assistance from supplier • communicates results to all concerned personnel, including JHSC • maintains permanent records. 	<p>Established by Ground Control Department.</p> <p>Generally accepted holding capacities are 1 ton per foot (SS-33) and 1.5 tons per foot (SS-46).</p>	<p>Investigate causes of poor pull test performance (e.g. bolt manufacturing issue, hole diameter); remedy situation.</p>

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4. Swellex and other water-inflated bolts	Regular pull tests are conducted to confirm to assess installation quality and bolt performance.	Ground Control Department and/or ground support supplier conduct pull tests.	Ground Control Department: <ul style="list-style-type: none"> • establishes test schedule • analyses data, with possible assistance from supplier • communicates results to all concerned personnel, including JHSC • maintains permanent records. 	Established by Ground Control Department. Generally accepted holding capacities are 3-5 tons per foot (Mn12).	Investigate causes of poor pull test performance (e.g. hole diameter, low air pressure, under-inflated bolt, etc.); remedy situation.
5. Dynamic bolts and other specialty bolts (MCB, D-bolt, Yield-Lok, Dynatork, Versabolt, MD Bolt)	Regular pull tests are conducted to confirm to assess installation quality and bolt performance.	Ground Control Department and/or ground support supplier conduct pull tests.	Ground Control Department: <ul style="list-style-type: none"> • establishes test schedule • analyses data, with possible assistance from supplier • communicates results to all concerned personnel, including JHSC • maintains permanent records. 	Established by Ground Control Department.	Investigate causes of poor pull test performance (e.g. poor resin quality or expired resin, hole diameter, improper spin or hold times, etc.); remedy situation.

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6. Spin cables (Strand-Lok)	<p>Regular pull tests are conducted to confirm to assess installation quality and bolt performance.</p> <p>Pull tests should be conducted to determine the resin bond strength (tons/ft).</p>	<p>Ground Control Department and/or ground support supplier conduct pull tests.</p>	<p>Ground Control Department:</p> <ul style="list-style-type: none"> • establishes test schedule • analyses data, with possible assistance from supplier • communicates results to all concerned personnel, including JHSC • maintains permanent records. 	<p>Established by Ground Control Department.</p> <p>A generally accepted target bond strength is 1 ton/inch.</p>	<p>Investigate causes of poor pull test performance (e.g. poor resin quality or expired resin, hole diameter, improper spin or hold times, etc.); remedy situation.</p>
7. Cable bolts (cement or resin grouted)	<p>Regular tests are conducted to confirm to assess installation quality and bolt performance.</p> <p>Tests may include pull tests, tensioning of cables to confirm installation quality, checking cement bag counts, visual assessment of grout consistency, and UCS testing of grout cylinders prepared during mixing.</p>	<p>Ground Control Department and/or ground support supplier conduct tests.</p>	<p>Ground Control Department:</p> <ul style="list-style-type: none"> • establishes test schedule • analyses data, with possible assistance from supplier • communicates results to all concerned personnel, including JHSC • maintains permanent records. 	<p>Established by Ground Control Department.</p>	<p>Investigate causes of poor test performance (e.g. high water:cement ratio, improper hole diameter, empty tubes following installation, etc.); remedy situation.</p>

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8. Shotcrete (dry & wet processes)	<p>Regular tests are conducted to confirm that installed shotcrete is of the proper thickness and quality. Tests may include:</p> <ul style="list-style-type: none"> • drilling holes to measure shotcrete thickness • slump and temperature tests • panel tests • RDP tests • UCS testing of grout cylinders prepared during mixing. 	<p>Ground Control Department, Operations Department, ground support supplier and/or outside organization conduct tests.</p>	<p>Ground Control Department:</p> <ul style="list-style-type: none"> • establishes test schedule • analyses data, with possible assistance from supplier • communicates results to all concerned personnel, including JHSC • maintains permanent records. 	<p>Established by Ground Control Department.</p>	<p>Investigate causes of poor test performance (e.g. high water:cement ratio, application technique, etc.); remedy situation.</p>