AUTONOMOUS MINING WORKING GROUP MEETING

May 25, 2023
**ANTITRUST COMPLIANCE**

<table>
<thead>
<tr>
<th><strong>DO’s</strong></th>
<th><strong>DO NOT’s</strong></th>
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<tr>
<td>• Prepare and circulate written agendas for all GMG Annual, Board, and committee meetings, and any other meetings that may entail roundtable discussions among competitors. Conduct all such meetings pursuant to the previously prepared written agendas, and prepare clear, concise, accurate, and unambiguous written minutes of each such meeting.</td>
<td>• Engage in any discussions with or among any competitors, regarding prices, costs, sales, margins, plans, schedules, bids, transportation rates, terms of sale, or any marketing or competitive information that could affect pricing.</td>
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<td>• Avoid all loose, facetious, or careless remarks, especially those in writing, that could be misconstrued as posing antitrust problems if read out of context.</td>
<td>• Engage in any discussions with or among competitors which relate to customers, sales territories, production, capacity, amount of reserves, output, or any other information relating to production or output.</td>
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<td>• Review all matters of potential antitrust sensitivity with the GMG CEO or other designated staff person. Such matters would include, for example, any proposed discussion of prices, limitation or allocation of production, division or allocation of markets or customers, and boycotts or refusals to deal with prospective customers. When in doubt or when otherwise appropriate, GMG staff will review such matters with legal counsel.</td>
<td>• Exchange or discuss any other confidential statistical or financial information of any company.</td>
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<td>• Assume that foreign sales or production are not subject to your country’s antitrust laws.</td>
<td>• Discuss the advantages, desirability, or possibility of eliminating or impairing any competition, whether existing or potential, foreign or domestic.</td>
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<tr>
<td>• Guess. When in doubt, get help-consult with GMG staff / representative and legal counsel.</td>
<td>• Assume that foreign sales or production are not subject to your country’s antitrust laws.</td>
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5/25/2023
BE FRIENDLY AND PATIENT
BE WELCOMING
BE RESPECTFUL
BE CONSIDERATE
WHEN WE DISAGREE, TRY TO UNDERSTAND WHY
A SIMPLE APOLOGY CAN GO A LONG WAY
BE CAREFUL IN THE WORDS THAT YOU CHOOSE
MODERATE YOUR EXPECTATIONS
DO NOT INSULT OR PUT DOWN OTHER COMMUNITY MEMBERS (INDIVIDUALS AND COMPANIES)
AGENDA

Anti-trust Policy and Code of Conduct Reminder

Safety Share

GMG Working Groups - Structure and Processes Review

Autonomous Mining Working Group Overview

Project Updates

• Implementation of Autonomous Systems in Mining v2
• System Safety for Autonomous Mining
• Small Vehicle Automation
• Designing Zero Entry
• ISO TC82-SC8
Safety share
A perfect example of control identified but incorrectly applied
NSW Mining Update – Near hits and Collisions

- All Mines in NSW
- NSW Underground mines
- NSW Surface mines
- We should all accept that across all sectors near-misses would be significantly under-reported to mine operators
## WHO WE ARE

We are a global, multi-stakeholder network of “doers” in the mining industry who openly discuss challenges and opportunities and collaborate on solutions and the materials to support their implementation.

We achieve this by collecting industry knowledge and making it available in a structured way.

## PURPOSE

Working together to be a catalyst for the operationalization of innovation in the global mining industry to improve the safety, sustainability and productivity of our mines.

## CRITICAL FOCUS

- Common language and processes and good operational practices
- Data integration, interoperability and management
- Enabling innovation and technology advancement
- Decarbonization and ESG
- Safety, culture and skills

## VALUES

- Inclusivity
- Accessibility
- Collaboration
- Integrity
- Encouragement
Working Group Steering Committees
Steer a working group, launching projects that will result in valuable and relevant guidance documents.

Who can join? Leaders at GMG member companies

Project Steering Committees
Govern a project, ensuring the timely delivery of a high quality, relevant guideline, white paper, etc.

Who can join? Subject matter experts at GMG member companies

Projects
Focused efforts that produce tangible guidance for the benefit of the global mining community.

Who can join? Subject matter experts

Working Groups
Communities of interest focused on mining industry topics or fields, formed based on what the industry identifies as priority areas. The Working Groups launch and oversee projects.

Who can join? Anyone!
GMG’s Working Groups represent major fields related to the mining industry aimed at addressing the industry’s most pressing issues and challenges.

The purpose of Working Groups is to create communities of interest based on industry need for collaboration to advance innovation, provide guidance, and share best practices.
The Autonomous Mining Working Group is focused on assisting the industry with its ongoing digital transformation and helping operations achieve the benefits that autonomous systems can offer.

The group is built by subject-matter experts, leaders from inside and outside the industry, suppliers, operators, and those interested in implementing autonomous systems in mining.
AUTONOMOUS MINING FOCUS AREAS

➢ Operational readiness
➢ Implementation and operations
➢ Safety
➢ Autonomous-led design
AUTONOMOUS MINING PUBLICATIONS

System Safety for Autonomous Mining
White Paper, September 2021

Guideline for Applying Functional Safety to Autonomous Systems in Mining, August 2020

Guideline for the Implementation of Autonomous Systems in Mining, April 2019
GMG PROJECT LIFECYCLE

PRE-LAUNCH

- Project steering committee guides development of the volunteer structure to enable content generation
- Phase completed when a complete rough draft is signed off by the Project committee
- Stakeholders: Ongoing verification of required expertise

LAUNCH

- Edited document to working group for final review
- Comments sent to the Project steering committee if revisions are needed
- Potential second working group review
- Stakeholders: Ongoing verification of required expertise for review

GUIDELINE DEFINITION

- Project steering committee guides development of the volunteer structure to enable content generation
- Phase completed when a complete rough draft is signed off by the Project committee
- Stakeholders: Define matrix of stakeholders and expertise required

CONTENT GENERATION

- Project, communications, and engagement plans developed
- Project steering committee established
- Stakeholders: Ensure adequate input and agreement

TECHNICAL EDITING, LAYOUT, FINAL REVIEW

- Working group members vote on whether to publish the guideline
- GMG Executive Council has the final vote and ensures guideline adheres to GMG core principles
- Stakeholders: Ensure sufficient stakeholder representation in vote

VOTE & PUBLICATION

- Clear problem statement and industry demand
- No competing efforts
- Stakeholders: Identify and consult

INDUSTRY EDUCATION & FEEDBACK

- Project steering committee guides creation of post-publication plan for GMG to carry out
- Dissemination of guideline throughout companies and industry
- Use and impact tracking to help determine if a new version is required
- Stakeholders: 1. Industry awareness to promote use and ensure value; 2. Feedback loop
There are a number of content development approaches and coordination of work for the different stages of content generation. Below are some examples, but each project should develop its own approach as part of the project planning stage. All approaches however should always be collaborative and flexible so as not to become restrictive to volunteers.

<table>
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<tr>
<th>Content Generation Phase</th>
<th>Description</th>
<th>Approaches</th>
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<td>Early content generation</td>
<td>Volunteers draft the content of the different sections of the publication</td>
<td>• In-person and virtual workshops&lt;br&gt;• Sub-group volunteers work asynchronously with check-in meetings to update on progress and assess next steps&lt;br&gt;• Sub-group volunteers meet to generate content together</td>
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<td>Draft review</td>
<td>Project Steering Committee will review the existing content and advise on how to complete the draft</td>
<td>• Project Steering Committee meetings to review</td>
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<td>Late content generation</td>
<td>Based on the input from the Project Steering Committee, any missing content will be drafted. This may require input from specific stakeholders, refinement or further development of certain sections, the adding of missing sections or the moving of certain content or suggestions to a “parking lot” for future editions.</td>
<td>• Peer review workshops (virtual or in-person)&lt;br&gt;• Sub-group revisions – can be done either independently or in sub-group meetings&lt;br&gt;• Volunteers work directly with GMG’s technical editors to revise content</td>
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<td>Final project review</td>
<td>Workshops held when the rough draft is nearly complete to run through the document to refine what is there and identify if further work is needed before the Project Steering Committee signs off on the initial draft and sends the draft for the Working Group review. At this point the content generation phase is complete.</td>
<td>• Workshops – virtual and in-person</td>
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SYSTEM SAFETY FOR AUTONOMOUS MINING

This guideline aims to provide guidance and best practices on applying a system safety approach to autonomous systems in mining. A system safety approach provides an overview of the overall effectiveness of the safety controls that extends beyond the machines and can be a useful qualitative tool for operations when assessing the overall safety of their systems. This type of systems approach is especially important as highly autonomous and highly integrated solutions evolve.
System Safety Lifecycle:

- An introduction to the “V” Model approach for a project lifecycle and how it can apply to system safety
- Considerations around operations philosophy, developing an operation model, and defining how to build the system use case

- Considerations around system safety management planning, including what topics the plan should cover
- Guidance on developing a risk assessment plan and hazard identification techniques
- Guidance on verification and testing, test management and planning, and transitioning to operations
System Safety Management Activities:

- Considerations around change management, leveraging existing processes when making modifications, and communications strategies
- Guidance around system upgrade management, configuration management, and training and competency management
- Information about dealing with systematic failures
- Guidance on monitoring safety controls, defining safety performance indicators, safety assurance, and maintenance plans
Safety Case Development:
Provides guidance on developing a safety case to communicate a clear and comprehensive argument that a system is acceptably safe to operate in a particular context.

- An introduction on what a safety case is and the stakeholders involved
- An outline of the typical headings and content expected in a safety case report

Product Upgrade Development:
This section focuses on the upgrade process from a system, hardware, and software level. The structure of this section may change, but content could include:

- Considerations around upgrades, including software release notes, continuous improvement processes, OEM specific changes and fixes
- Guidance on software safety management
- Defining a major upgrade and how a product upgrade can influence the safety case
- Considerations around how operators can give feedback to OEMs, how to collect that information and how it can be shared
GET INVOLVED

Goals:
- Complete draft by end of August 2023 to initiate the review process.
- Complete review by the end of the year.

Needs:
- Subject matter experts in autonomous mining for:
  - Maintenance and upgrade validations
  - Human systems and integration
  - OEM development processes that include the integration to existing systems.
  - Safety Case Development
- Continue adding to content and comment on working draft.

Upcoming Workshops
Section Meetings:
- June 20: Lifecycle section
- June 21: Management Activities section
- June 21: Safety Case Development section
- June 22: Product Upgrade Development section

Next Project Meeting:
August – Exact date TBC
IMPLEMENTATION OF AUTONOMOUS SYSTEMS GUIDELINE – VERSION 2

This guideline discusses the important factors related to implementing autonomous systems in mining using current industry practices and common terms of reference. It provides guidance and considerations on justifying, planning, developing, testing, implementing, and deploying autonomous systems.

It offers high-level guidance which recognizes that different levels of autonomous system maturity exist across mining operations and that requirements are varied depending on the type of operation. It aims to be broad enough so that it can apply to a variety of situations and remain useful even as technologies advance.
Key Updates:

• Consideration given to underground mining
• A new subsection on the full lifecycle cost for the business case
• A new subsection on cybersecurity
• A new subsection on performance and metrics
• Expansion of the content on executing and deploying autonomous systems
GUIDELINE CONTENT

**Change Management:** Considerations and questions to ask specific to change management planning, critical success factors, and change management progression.

**Business Case:** Assists those planning or preparing a business case, including detail on considerations, value drivers, implementation and ongoing costs.

**Health and Safety:** Includes risk management and analysis, hazard identification, and emergency management planning.

**Regulations:** Promotes best practices around regulatory requirements, with high-level detail that recognizes that every region will be different. Content includes considerations and guidance for how to actively engage with regulators.

**Workforce, Community and Social Impact:** What to consider when engaging and preparing the workforce and community, including an engagement plan and a section on education and skills migration.
Operational Readiness:
- The application of autonomous technology, infrastructure requirements and considerations, cybersecurity, systems architecture.
- How deploying autonomous systems impacts the workforce and key factors to consider.
- Covering mine planning/design, process redesign, challenges around engineering design.

Deployment:
Offers guidance on deployment and commissioning of autonomous systems, including considerations around transitioning to operations, monitoring and assessments, and continuous improvement.
- Steps to consider before deployment
- Guidance on execution plans and commissioning activities
GET INVOLVED

• Sections ready to be reviewed:
  • Business Case
  • Regulations
  • Workforce, Community and Social Impact
• Sections under development:
  • Change Management
  • Health and Safety
  • Operational Readiness
  • Deployment

Project timeline:

Workshop in Sudbury (Canada) next week
Sections under development meetings May-August
Interviews/meetings with SME’s with deployment experience
Complete guideline review workshops (August-September)
SMALL VEHICLE AUTOMATION

This project discusses the requirements and considerations with implementation of small autonomous equipment, along with potential options that can help stimulate collaboration to increase real efficiency and enable further development, implementation, and adoption. This project aims to help enable successful adoption and provide a better understanding and awareness of the unique best practices and risks associated with them.
SURFACE vs UNDERGROUND... OR BOTH

**Surface**
- >100 tonne haul trucks
- Guidance to help new vendors to enter mining
- Requirements to integrate small autonomous haul trucks into the mine site

**Underground**
- Less than ~30 tonnes
- Equipment other than load and haul equipment
- Example content:
  - Mixed fleets from multiple OEMs
  - Traffic management systems
  - Mining cycles
GET INVOLVED

1. Two sub-committees (surface and underground) who will be clarifying the purpose and requirements

2. Reworking current draft based on the clarified purpose and requirements

3. Identify clear linkages between this project and the other autonomous mining guideline projects (~June)

4. Completion of the draft(s) in ~August

Seeking people with experience, knowledge, or interest in small autonomous vehicles for both underground and surface mining.
DESIGNING FOR ZERO ENTRY MINING

This white paper will discuss some of the benefits and opportunities, along with other design considerations associated with zero entry mining and what it can enable for the industry.

Additionally, through the development of demonstration projects, it will translate the zero-entry mining vision into a tangible framework enabling further discussion and collaboration between industry partners to accelerate the development of appropriate systems, processes, and guidelines that could enable a zero-entry mining operation.
WHITE PAPER FOCUS AREAS

- Principles
- Value proposition
- Enablers
- Systems, task, work design
- Pathways
DEMONSTRATIONS

Running collaborative demonstrations for companies to prove, figure out, and document what is required. The outputs will be documented and fed back into educational and guidance documents.

Potential demonstrator topics

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<th>People tracking with time and motions study for tasks</th>
<th>Consumer-driven disruption; demand-driven mining</th>
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<tbody>
<tr>
<td>Zero entry mine digital demonstrator</td>
<td>Surface demonstration sandpit</td>
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<tr>
<td>Autonomous mine post blast re-entry</td>
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GET INVOLVED

- Project steering committee
- Workshops to better define the guideline content

Currently, all content compiled in the live documents was drafted from the GMG technical writer based on participant input from workshops.
ISO TC82 SC8

SC8 Purpose:
Provide the international mining community and nations a formal global standards organizational structure with the focus and direction to address the automation and autonomous needs, priorities, and developments for global mining industry standards, with active collaboration of other mining stakeholders.

SC8 Scope:
Standardization in the field of advanced automated and autonomous processes, technologies, equipment, and systems in the mining sector, including both surface and underground mining.
GMG – OFFICIAL LIAISON ORGANIZATION TO SC8

• Liaison organizations make an effective contribution to the committee's work and may propose new work items for the committee to develop.

• Liaisons may also nominate experts to working groups (WGs) and hold Convenor or Project Leader roles within these WGs.

• Liaisons do not have voting rights.
WHY BE A LIAISON ORGANIZATION?

Benefits

An awareness and collaboration in ISO TC82 SC8’s standardization work will:
• enhance the quality and applicability of GMG activities and guidelines,
• accelerate autonomous equipment innovation within the mining industry

A liaison will compliment GMG developments by potentially reducing duplication of effort and improved identification of industry directions, needs, and requirements.

Goals

• Establish communication and collaboration between ISO TC82 SC8 and GMG’s industry liaison.
• Enable input and engagement of ISO TC82 SC8 to the broader GMG community, and vice versa, and establish meaningful connections between the group and key GMG stakeholders to compliment the activities of both
• Align GMG guidelines with the work of ISO TC82 SC8, and for ISO TC82 SC8 standards to become more broadly implemented to the benefit of the global mining industry
**CURRENTLY UNDERWAY**

**TC82 SC8 Lead – TC127 Joint Liaison**

**PWI 23724 - Emergency remote stop of mining equipment**
Lead: TC 82/SC8 - Joint: TC 127/SC2

**ISO/PWI 23725 - FMS Interface to Autonomous Haulage**
Lead: TC 82/SC8 - Joint: TC 127/SC3

**ISO/PWI 3502 - Reference framework and architecture for advanced automation and autonomy**
Joint: TC 127/SC3

**ISO/PWI 3510 – Communication Interface between autonomous mining machine and supervisor system**
Joint: TC 127/SC3

**TC127 Lead – SC8 Joint Liaison**

Joint: TC82/SC8

**ISO 21815 - Collision warning and avoidance**
Joint: TC82/SC8, TC195 Construction

**ISO/PWI 23870 - General standard for onboard mobile equipment secure high speed data communication**
Joint: TC 82/SC 8, TC22/SC31, TC23/SC15, TC23/SC19

**ISO/TS 15143-3 Worksite Data Exchange – Telematics data – Topographical elements.**
Joint: TC195 Construction

**ISO 7334 - Taxonomy and Definitions for Terms Related to Automated and Autonomous Machines**
NEW/PLANNED STANDARDS DEVELOPMENTS

**TC82 SC8 Lead:**

- TC82 Definition of Mining Equipment
- TC82/TC127 Haulage Truck Drive by Wire
- TC82 Multi-industry Common Autonomy Terminology and Taxonomy for all off-road Equipment.
- TC82/SC8 Terrain Data Formats
- TC82/SC8 Personnel safety Instrumentation
NEXT STEPS

• Prioritize GMG’s involvement in the various SC8 standards developments
• Nominate SME’s to represent GMG in those development projects
• Support ISO standards development with GMG input
• Leverage opportunities for GMG guidelines as seed documents to ISO standards and for GMG guidelines to support the awareness and use of ISO standards
THANK YOU