



**Remote Loading Project
(6 Foot Phase - Pre and Post Cleaning Jumbo
Drill Holes)**

**TesMan December 2014
Work Package Report**

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DECEMBER WORK PACKAGE:

- FOCUS UNDERGROUND DRILL HOLE SURVEY ON FURTHER OVERHAND, UNDERHAND AND DEVELOPMENT ORE HEADINGS
- COMPLETE APPROVAL OF WEB PAGE AND OCTOBER AND NOVEMBER WORK PACKAGES TO ADD TO PROJECT PAGE
- MAP THE PROJECTED PROTOTYPE CYCLE AND SCHEDULE FOR 2015
- MAP ONE VERSION OF THE PROJECTED COMMERCIAL CYCLE WITH IDENTIFIED TRANSFERABLE TECHNOLOGY OPTIONS
- SURFACE TEST FLUSHING TOOL AND COMPLETE PROTOCOL FOR TESTING NEW DESIGNS SAFELY UNDERGROUND
- GET FEEDBACK FROM ALL LOADERS ON THE FUNCTION OF THE FLUSHING TOOL
- FIELD TEST AND MAP WITH VIDEO EFFECTIVENESS OF IN HOLE FLUSHING TOOL
- COMPLETE DESIGN, FABRICATION AND START FIELD TEST OF IN HOLE IMPACT TOOL
- SOURCE AIR DRIVE COMPONENTS FOR THE LIFTER CLEANING AUGER TOOL V 1.0
- COMPLETE DESIGN CONCEPTS OF FIXED FEED TOOL FOR BOLT ON ARM POSSIBLY INCLUDE ABB TO DESIGN TEAM
- INVESTIGATE THE REQUIRED GEOMETRY OF A FIXED LOCATION FOR THE EXTENSION ARM VERSUS A LATERALLY SLIDING RAIL MOUNTING WHILE ACHIEVING 10 FOOT REACH AND REASONABLE FEED ANGLE OF HOSE INTO HOLE
- REVIEW SAFETY DEPT INVESTIGATION REGARDING PRE AND POST CLEANING
- WORK PACKAGES OCTOBER AND NOVEMBER APPROVED

EXECUTIVE SUMMARY

The key points this month are:

- The bulk of the work in December was targeting the completion of assignment of all conceptual designs to generate detailed designs for fabrication in Q1 of 2015 to generate the testing phase as soon as possible in Q2 2015
- All of the crucial components are now in the design stage which will place the project in a position to fabricate them in February and March
- Now the participation roles of 6 significant equipment suppliers have been identified bringing significant practical experience to the component and process final designs
- The team and project Managers for the sponsor companies will have the opportunity from January onwards to review an increasingly detailed schedule during the monthly meeting

IN HOLE CLEANING CHALLENGES

Present traditional cleaning methods of jumbo drill holes are:

- 4 foot wire for blockages at the entrance to the hole
- 5/8 “ diameter stiff semi conducting anfo loading hose feeding compressed air into the hole

Only the compressed air venturi effect of the anfo hose can service the entire length of the average 15 foot long 2 inch diameter hole.

The object of the remote cleaning tools is to supplement this range of tools to provide absolute accuracy in the depth that is definitively cleaned, by adding the ability to break and or remove material that is encountered, as well as data in the form of depth and if preferred vision in the hole. The motive common motive force for these tools is compressed air.

In an emulsion loaded heading, the loader still only has the same present choices to cleaning the hole, the emulsion unit offers the additional depth of loading of the hole, but the loader has to install a compressed air hose to clean the hole to start with. The added complexity of dealing with emulsion made it difficult to complete the planned testing of the hole cleaning flush tool. The additional activity around the conversion to emulsion also affected the mapping of drill holes.

Less than 100 holes were mapped, and no significant changes observed to the November summary, and therefore no summary is included this month. The raw data is analysed and recorded in the project database.

The challenges moving ahead will include:

- To get agreement on the method of provision of compressed air for regular hole cleaning, the method and quantity required and a process to test the cleaning in hole tools in January and February.
- An additional challenge will be identifying a more convenient process for providing the motive force required to power the final cleaning tools during the running of the 6 foot cycle testing in May and June.

To follow through with these points; meetings are scheduled with the mine area owner during January to discuss the details required to continue the detail process mapping to be followed during the tests.

STATUS OF DETAILED DESIGN AND FABRICATION SCHEDULES

Presently in the schedule there are:

- 8 new separate components used together to remotely clean and load the holes
- 6 available technologies to be used to support the process away from the face

Each new component will probably pass through at least 2 variations, from the first concept to the final working version, in development, as follows:

- Concept Design
- Detailed Design V 1.0
- Fabrication
- Hazard Analysis prior to underground testing
- Refit to adjust to the Analysis
- Document package for Client (including detailed drawings, hazard analysis, design document, operating procedures) prior to going onsite

THE STATUS OF THE 8 PROJECTED NEW COMPONENTS AGAINST THIS PLAN IS AS FOLLOWS:

- **IN HOLE ENDOSCOPE** to audit the conditions inside the drill holes visually – completed using off shelf parts and custom laptop programming to record results, in use throughout October, November and December
- **IN HOLE PNEUMATIC FLUSHING TOOL** to remove material from drill hole – process complete, compiling final document package for Client before testing onsite
- **IN HOLE PNEUMATIC IMPACT TOOL** to break obstacles in drill holes – presently in fabrication
- **IN HOLE COMBINED PNEUMATIC FLUSHING IMPACT TOOL** to streamline the above processes into a single tool – conceptual design complete, pending the final form of the above individual tools
- **IN HOLE WATER OR PNEUMATIC EXPLOSIVES FLUSHING TOOL** to remove anfo and or emulsion from the drill holes – concept complete, waiting for outline of pertinent regulations to accommodate in design, and the design of a micro pressure water motive process, if required rather than pneumatic

- **LIFTER COLLAR CLEARING AUGER** to remove material to expose the lifter – concept design is complete, presently resourcing suitable components, namely the inline pneumatic drive motor and gearbox
- **TWO AXIS ROBOTIC ARM AND CONTROLLER** to reach the face – the detailed design package is complete and will be reviewed in January for a final design incorporating all new lessons and input from experienced robotic arm manufacturer ABB.
- **FEED AND ROTATIONAL AND CONTROLLER** to control the tools and hoses into and out of the drill holes while providing depth and over force control – the conceptual design and required specifications is complete. The detailed design package will be completed by early February, with input from NORMET to benefit from their loading experience.

THE STATUS OF THE 6 MORE CONVENTIONAL COMPONENTS REQUIRED ARE AS FOLLOWS:

- **LOADER MOUNTING BRACKET FOR COMPONENTS AND SURFACE AND UNDERGROUND TESTING AND TRANSPORTATION STAND** – concept is complete and design will only take place after the above new components are close to completion
- **CONTROL SCREEN TABLET AND PROGRAMMING** concept is complete and design will only take place after the above new components are close to completion
- **RANGE MONITORING TOOL** – this is a tool TesMan has already developed and will rent to the project in a suitable format
- **SHEPPARD'S HOOK FOR GATHERING CAPS** - concept is complete and design will only take place after the above new components are close to completion
- **PAINT STICKS FOR MARKING FACE** concept is complete and design will only take place after the above new components are close to completion
- **CUSTOM PORTABLE ELECTRICAL POWER SUPPLY** for the screen, arm and feed motors and controllers in the basket – a custom load testing kit has been fabricated and is ready to analyse average and peak power demands for the final portable power specification required in the basket, either from the loader batteries or from portable batteries.

PARTICIPATION OF EQUIPMENT SUPPLIERS IN PROJECT PROCESSES

This remote loading project has two objectives for the clients:

- The first challenge is to resolve the missing technologies and process to remotely clean and load jumbo development drill holes from a minimum 6 foot distance from the face, and prove the solutions in a prototype cycle at the client mine in production conditions.
- The second challenge is to engage equipment suppliers who service this market of face loading and drilling to participate, benefit with data and applicable solutions from the project, to continue and commercialise their variation of the remote loading capability to provide to the market

The following suppliers are participating in the following manners:

- **Atlas Copco** has decided to focus specifically on the learnings around how the drilling affects and could improve the drill hole cleaning and loading conditions. This will include a series of short experiments with the project team to quantify the effects and benefits of specific drilling features. This will result in modifications and information for the suppliers to assist in supporting the remote loading through appropriate drilling features and practices.
- **NORMET** is focussed specifically on the remote cleaning, the mechanical remote loading technologies, and to this end is offering consulting on the detailed design packages that the project team is developing to add the benefit of their own experience
- **Maclean Engineering** is supporting the provision of specification data of the loader presently in use underground at the test mine, to ensure safe accommodation of the new components.
- **Orica** and **Dyno Nobel** are going to continue their participation from phase 1 of the project, by participating in the workshops review the planned cleaning and explosive removal processes
- **ABB** as one of the larger international robotic arm suppliers is offering consulting in the form of reviewing the custom two axis design of robotic arm being designed by the project team, this also benefits ABB by providing the field data of performance versus design for a robotic arm in the production environment of tunnelling

MINE IDENTIFIED DANGER ZONE QUANTIFIED FOR ROBOTIC ARM DESIGN REACH

During December a decision was made to identify the danger zone in order to know what the minimum reach of the robotic arm would need to be to meet the mine requirements, both present and future.

The present project scope is 6 foot from the face. In the first 3 months of field work it has become apparent that 6 foot is the bare minimum. The toe of the undercut faces in the cut and fill development can hangover up to a worst case scenario of 4 feet, but only at the toe. The mine has identified a danger zone on development faces of more than 12 feet back from the toe of a 12 foot high face.

The conclusion is a range of zones described as follows for any height of face:

- **For Development in Virgin Material** – A distance of 8 feet from the toe of the face reducing to a distance of 6 feet from the face at a height of 6 feet above the ground (base of rail) all the way to the ceiling of the drift
- **For Development in Under Cut Headings** – an additional range of up to an absolute maximum of 4 feet at the toe of the face for a total of 12 feet at the toe of the face distance from the face, reducing to a distance of 6 feet at a height of 6 feet above the base of rail, all the way to the ceiling or back of the drift or tunnel.

This analysis will be used in the review of the Detailed Design of the Two Axis Arm which is scheduled to be complete on January 05 2015, to be reviewed and modified with the support of ABB prior to January 31 2015, ready for fabrication during February 2015.

A new task for January and February is to complete a number of arm design formats to achieve a variety of reaches from the basket to the tunnel face.

WEIGHT CHALLENGES AND SOLUTIONS THROUGH GEOMETRY REVIEW

A more detailed analysis of the geometry required of the arm to be effective at achieving the maximum ranges of 10 to 12 feet was concluded, and some additional benefits were identified:

- A central single anchor point in front of the basket is sufficient which removes the need to have a lateral travel, this can be confirmed during testing on surface
- Having the feed unit mounted underneath the basket places the weight load closer to the stem of the boom reducing the effective mass required of the two axis arm to support
- This offers the opportunity to further reduce the design weight of the two axis arm which was designed to handle 20 kg load at the first joint

- This additional arm capability also affords the opportunity to offer longer extensions to the arm to cover a 10 or 12 foot reach

Some of the challenges to be resolved during the design review in January that were identified are:

- The new arm lengths to ensure the additional reach while allowing the end of the hose to rotate back to have the cap installed in the end of the loading hose
- The nature of the carousel required to load the cleaning tools or the loading hose into the feed tool
- The final location and process allowing the operator to change and maintain the tools and loading hose from the basket without reaching ahead of the basket

The review added no power requirements to the basket mounted power supply for the feed and or arm.

GAP ANALYSIS OF 6 FOOT PROTOTYPE TOOLS AND METHODS

In December the Prototype 6 Foot Remote Development Cycle was mapped as scheduled. This Map will be expanded in the January and February to include all the preparation planning that is required to ensure no missing details for the May and June cycle testing:

- The actual location of the cycle testing
- The actual mine owned equipment to be available in this area during the cycle months
- The actual crews to be involved
- A Gap Analysis of the Remote Cleaning and Remote Loading related New Technologies, new processes or New methods that need to be completed, and tested ahead of time
- The provision of additional detail of work to be included in the upcoming schedule and time sensitive completion dates

The preliminary cycle map was completed in December as it is presently planned to occur, and is available as a separate pdf format of an excel sheet.

As a result of this initial mapping the following points were noted as outstanding:

- Methods and preferably automated tools are required to confirm daily the minimum distance of each process from the face to confirm that the umbrella 6 foot from the face rule is not violated
- A test phase has been scheduled to verify each component of the cycle one at a time before accumulating them into a complete cycle (example: using a shepherd hook for capturing the caps for connection)

- The initial mapping has to be detailed initially with the operating management and crews to detail which specific equipment is required, and to make plans where the available equipment might not be suitable
- More detail will evolve as this process evolves over the next three months

IDENTIFYING ONTARIO REGULATIONS REGARDING CLEANING EXPLOSIVES

The following processes are scheduled to research and address any legal restraints that need to be addressed in the explosives removal from the jumbo drill holes after blasting:

- The company safety department review of the acts and regulations will be completed early January and documented with recommendations for the project team in the January report
- A series of workshops is scheduled to be planned with the explosives suppliers involved in phase 1 of this project, Orica and Dyno Nobel, first to review phase 1 conclusions regarding management of snap slap and shoot risk, and then to brainstorm present and possible practices employed to mechanically remove explosives from drill holes
- A brainstorm workshop by the project team after the accumulation of challenges, boundaries and possible solutions to identify the most appropriate motive force to clean remove explosives and caps from blasted jumbo drill holes
- Evaluating a trip to see mechanical loading to ensure feed meets design requirements to be identified possibly through NORMET, Orica, or Dyno Nobel

THE HEALTH OF THE PROJECT COMMUNICATION PROCESS

The status of the project communication process is as follows:

- The project website for making the monthly work packages, as well as the October and November work packages have been approved and will be pushed up to the TesMan website in January.
- The approved October and November work packages have been provided to the equipment suppliers.
- The mailing list will be forwarded out in January 2015 when this is completed

JANUARY WORK PACKAGE:

- UPDATE OTHER EXPLOSIVE SUPPLIERS ABOUT PROGRESS AND BUDGET AND IDENTIFY A PARTNER FOR FEEDER IF NORMET OUT OR TOO LONG
- COMPLETE DESIGN OF LIFTER CLEARING AUGER TOOL V 1.0
- FABRICATION OF THE PORTABLE FEED (AND ROTATION) HAND TOOL V 1.0
- MAKE DECISION FOR EXTENSION ARM TO HAVE LATERALLY SLIDING RAIL OR A SINGLE QUICK FIT FIXED CENTRAL LOCATION
- QUOTE FROM SUPPLIER FOR FAB OF FIXED FEED TOOL V 2.0 FOR BOLT ON ARM (TO INCLUDE MECHANICAL LOADING SAFETY FEATURES AS WELL AS MECHANICAL CLEANING SAFETY FEATURES)
- IDENTIFY TRANSFERABLE TECHNOLOGY LOCATIONS & SCHEDULE A VISIT
- FINALISE PLAN FOR FLUSHING INFLUENCE TEST WITH DRILL OVER 4 ROUNDS (2 WITH AND 2 WITHOUT FLUSHING, HIGH PRESSURE)
- ADD TO PROJECT WEB PAGE A HIGH LIGHT OF PHASE 1 GAP SNAP SLAP AND SHOOT CONCLUSIONS FOR MECHANICAL LOADING SHOCK TUBE IN ONTARIO
- PUSH WORK PACKAGE UP TO WEBSITE

FUTURE MONTHS WORK PACKAGES AT PRESENT

These work packages are detailed in the project schedule and are altered at the end of each month to reflect progress, as well as challenges and solutions.

FEBRUARY WORK PACKAGE:

- COMPLETE FABRICATION AND START TESTING OF LIFTER CLEARING AUGER TOOL V 1.0
- DESIGN BUILD AND FIELD TEST A COMBINED IN HOLE FLUSHING AND IMPACT CLEANING TOOL
- TEST AND ANALYSE FLUSHING EXPERIMENT TEST DATA
- AWARD FABRICATION OF BOLT ON ARM WITH FEED (AND ROTATION)
- AWARD DESIGN FABRICATION OF PALLOT MOUNTED TEMPORARY SUPPORT FOR COMMISSIONING AND TESTING THE ARM, FEEDER AND CLEANING TOOLS, AS WELL AS LOADING FUNCTION
- AWARD FABRICATION OF ALL CLEANING TOOLS FOR BOLT ON FORMAT
- PROGRAM AND TEST TOUCH SCREEN FOR LOADING ARM CONTROL (AND DEPTH)
- COMPLETE THE DESIGN OF THE PROTOTYPE WORK CYCLE WITH COMPARATIVE TIMES
- PUSH WORK PACKAGE UP TO WEBSITE
- SCHEDULE FIELD TRIPS TO TRANSFERABLE TECHNOLOGIES

MARCH WORK PACKAGE:

- DEVELOP PROTOCOL WITH MINE FOR SAFE TESTING OF BOLT ON ARM
- INITIAL UG TESTING OF BOLT ON REMOTE CLEANING ARM, TOOLS AND SCREEN
- FINALISE BEST ENDOSCOPE AND COMPLETE DRIVER SOFTWARE TO ALLOW MINER TO MANAGE SETTINGS FOR TRANSFERABLE TECHNOLOGY LIST
- WORKSHOP REVIEW THE PROTOTYPE WORK CYCLE WITH THE CREWS
- PRACTICE RUNS OF PROTOTYPE CYCLE TO DEVELOP PROCEDURES
- PUSH WORK PACKAGE UP TO WEBSITE
- SETUP COMMISSIONING AND TESTING OF EQUIPMENT IN A TEST MINE LOCATION FOR 30 DAY SHAKE DOWN

APRIL WORK PACKAGE:

- COMPLETION OF AVERAGE CYCLE TIMESTUDY TO COMPARE TO PLAN CYCLE
- PROGRAM PERSONNEL FACE SCAN LIDAR FOR PROTOTYPE CYCLE

MAY WORK PACKAGE:

- RUN PROTOTYPE WORK CYCLE IN DESIGNATED AREA WITH TRACKING

JUNE WORK PACKAGE:

- RUN PROTOTYPE WORK CYCLE IN DESIGNATED AREA WITH TRACKING
- FINAL REPORT

