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Constructability, Operability, Maintainability and Safety (COMS) by Design (formerly HED-MAN-008)

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GUIDE

PURPOSE

The purpose of this guide is to define the COMS process and provide guidance for applying COMS to projects such that all hazards for construction, operation, and maintenance of the new or modified systems, structures and components will be considered, identified, and addressed by the design team during the various phases of the project. This will allow all tasks to be completed effectively, safely and with minimum impact to the environment throughout the project life cycle.

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1. INTRODUCTION

The purpose of this guide is to define the COMS process and provide guidance for applying COMS to projects such that all hazards for construction, operation, and maintenance of the new or modified systems, structures and components will be considered, identified, and addressed by the design team during the various phases of the project. This will allow all tasks to be completed effectively, safely and with minimum impact to the environment throughout the project life cycle.

The important goals of COMS are to:

- Allow the designer to identify COMS issues early on in the project engineering process
- Disposition the COMS issues through design – “design out”
- Properly document the action in a systematic and traceable manner
- Draw on expert input through team collaboration.

This guide is part of the quality Design/Engineering (Change) process that comprehensively identifies, disposes, and records user-centred issues and needs pertaining to personnel safety and environmental aspects in construction or installation, operation, and maintenance of the new or modified system.

The COMS process applies ‘user-centred’ design principles throughout the project engineering cycle. To address user-centred issues fully requires a team effort and close cooperation amongst the technical subject matter experts (SMEs) in conventional safety, industrial hygiene, ergonomics, human factors engineering, environment, construction, operations and maintenance.

This is part of the quality engineering process to ensure quality design through comprehensive consideration of the activities of a project throughout its life-cycle. The process and tool boxes (Checklists – Appendix B and C) provided in this guide offer a more focused and structured approach which adds to the design process.

Both high level COMS Summary Checklist – Appendix B and the more COMS Detailed Checklists – Appendix C, are provided to guide the user through the exercise. Greater benefit can be realized through early application of COMS in the project engineering cycle.

2. PURPOSE AND SCOPE

The purpose of this document is to guide the Designer/Design Team on how and when to perform the following during the project engineering cycle:

- Identify user-centred issues related to Constructability, Operability, Maintainability, and Safety (COMS) for new designs and specific engineering changes
- Assess the significance of the issues identified
- Disposition the issues appropriately.

This process requires that the above steps be documented. Documenting the process and output allows one to demonstrate due diligence of the engineering performed, identifies COMS issues and disposition for the legacy of the project.

This process and tools provided are designed with the full range of projects in mind, including major green-field projects, small-scale development projects, plant rehabilitations and maintenance projects, retrofits, as well as equipment upgrade and modification projects. This process is expected to be applied to projects undertaken by both in-house engineers and/or consultants.

3. PROCESS OVERVIEW

This process directs the Designer/Design Team to identify COMS-related issues, and dispose of them through design, administrative controls, or in another phase of the design life-cycle.

This COMS procedure is intended to be a ‘scaled’ approach to ensure amount of effort is commensurate with the size and scope of the project. As well, different tools will be applied at different phases of the project to align with the needs and level of knowledge of details at the various stages. At the early stage of the project, considerations tend to be at the higher level addressing the “bigger picture”; at the latter stage of engineering, focus is on the system and components levels and will be more detailed and specific. The questions/prompts in the toolboxes are designed to complement with the needs. The checklist provided in Appendix C “COMS Detailed Checklist” can be tailored to meet the needs of the type and size of the project.

The COMS process is intended to be iterative, identifying and disposing COMS-related issues as they arise at each phase of the design/change cycle. The Design Team Leader (and for small projects, the designer) shall ensure that the sequence of identifying and dispositioning COMS issues is completed at each phase of the design/change cycle. The Action Plan shall be kept and passed onto the next phase so that the list is continuously addressed at the best time in the design process. Diligent application of this process will help to avoid design oversights related to construction/installation/removal, operation, maintenance of a design/change, and promotes a design acceptable to both the user (operators and maintainers) and designers.

For smaller projects, the review team membership can be scaled down accordingly, and for very small engineering tasks, the review team exercise can be undertaken by the designer with consultation of the various experts.

COMS involves three basic steps:

Step 1 Where possible, adopt a design concept (or construction method) which eliminates identified construction, safety and environmental concerns. This is best achieved at the early concept and definition phases.

Step 2 Make adjustments or modify the design to eliminate the issues identified during preliminary design, detailed design, and construction/installation/removal stages. This covers all safety hazards, environmental and other aspects during Construction/Operation and Maintenance of the project.

Step 3 Follow-up on COMS issues identified that cannot be eliminated with “Non-design” (administrative) solutions.

The options that can be chosen to deal with the various hazards are summarized below in Table 1 by order of preference.

Table 1: Options for Dealing with Various Hazards

Option	Description
a) Design to eliminate COMS issues	Eliminate the issues or risk from the project, job, or facility; (e.g., eliminate falling hazards by placing equipment at floor level, automate material handling, substitute hazardous material with non hazardous material, etc.)
b) Design to minimize COMS issues	If issues cannot be eliminated: • Minimize its potential impact by using less hazardous materials/process, (e.g., provide handles on objects, lower working heights, lower voltage; etc.) • Minimize chance of human error (e.g., use easily read displays, minimize number of decision making steps, etc.) • Provide devices to warn workers of danger, (e.g., flashing lights, warning signs, auditory signals, etc.) • Provide physical barriers (e.g., enclosures, guard rails, use of safety devices) • Reduce energy consumption • Use secondary containment to prevent any leaks from the primary containment.
c) Non-design to COMS issues	If a COMS issues cannot be eliminated and the hazards have been controlled to the point where the benefits do not outweigh the costs of additional controls: • Control hazards through the use of personal protective equipment and safety procedures • Incorporate procedures into the design descriptions and ultimately into construction, operating, and maintenance procedures and practices • Administrative (procedural) resolutions shall be built into installation, construction, operation and maintenance procedures as appropriate

Options are preferred from a) to c), as shown above, since ‘designing-out’ COMS issues is the most effective approach. Factors such as time, cost, system constraints, resources, and future modifications can affect the final decision.

4. RESPONSIBILITIES

The accountability for application of the COMS process rests with the designer for small projects and the design team leader for large project. The team leader varies with the project and could be the project engineer. Throughout the engineering life-cycle, the designer or design team is responsible to make use of the tools and apply COMS in their engineering and design process.

As the project moves into Definition (preliminary design) and Execution (detailed design) Phases, formal team reviews are recommended. The COMS Review can be conducted as part of the typical Design Review except that COMS factors are injected into the review process and make the Design Review much more comprehensive and structured. The right people including specialists should be included to form the Review Team so that one would have all the experts around the table. This would ensure all issues are identified and solution put forward.

A COMS Review Team is typically composed of the following members and may vary based on the size and type of project involved:

- A COMS facilitator
- The Design Team and Design Team Leader
- Project Engineer
- Plant personnel with Operations Experience
- Plant personnel with Maintenance Experience
- Construction specialist (Site manager/supervisor)
- Subject Matter Experts (SME) in:
    - Safety
    - Environment
    - Ergonomics/Human Factors Engineering
    - Industrial Hygiene

The roles and responsibilities of the team members are described in the following Sections 4.1 to 4.5.

4.1 COMS Facilitator

The COMS facilitator is responsible for:

- Ensuring procedural compliance of COMS throughout life-cycle of the project;
- Ensuring initial COMS reviews and subsequent updates are completed.
- Work with the Design Team Lead in reviewing the checklists in Appendices B & C, and tailor the checklists for the specific project

For small projects, the COMS facilitator can be the Design Team Leader or Project Engineer.

4.2 Design Team Leader

The Design Team Leader or the Contractor's Design Team Leader is responsible for:

- Ensuring procedural compliance of COMS during the design phase (Detailed Engineering for the design/change);
- Check COMS database (to be set up) for COMS reports for similar design
- Identify and coordinate COMS review team (including COMS facilitator if required);
- Follow-up on all COMS issues;
- Process sign-off;
- Recording the results of the COMS reviews and action plans.

4.3 Design Team Members

The Design Team Members are responsible for:

- Providing an overview and background information on the design;
- Providing comments on COMS issues identified by the Technical Subject Matter Experts;
- Considering the feedback provided by the Technical Subject Matter Experts in their design.

4.4 Project Engineer

The Project Engineer is responsible for:

- Providing an overview and background information on the project;

- Providing comments on COMS issues from the perspective of project cost, schedule and other considerations;
- Considering the feedback provided by the Technical Subject Matter Experts in their design.

4.5 Technical Subject Matter Experts (SME)

The Technical Subject Matter Experts (e.g. Conventional Safety Advisor, Ergonomist, Human Factors Engineer, Industrial Hygienist, Environmental Advisor, Plant Personnel [Operation and Maintenance], and Construction Specialist) are responsible for:

- Collaborating closely to ensure that all user-centred aspects (from their expertise) of the design/change are considered fully and efficiently, and that the COMS objectives are addressed and met in a coordinated manner;
- Providing review of analyses completed by Design Team members, as required;
- Providing input related to safety criteria, safety design guidelines, and assessment of COMS issues, as required.

Selection of Technical SMEs depends on the scale of the project and the type of system being designed/changed.

5. INTEGRATION OF COMS INTO THE DESIGN/ENGINEERING CHANGE PROCESS

The COMS process should be applied to all phases of the project. These include:

- Identification (pre-concept) Phase – where opportunities and/or issues are identified (see Section 5.1);
- Initiation (Concept) Phase – different concepts are assessed (see Section 5.2)
- Definition Phase – when project scoping, design requirements, preliminary design and performance specifications are developed (see Section 5.3), and
- Execution Phase – when detailed design is carried out (see Section 5.4)
- Close-out Phase – lessons learned (see Section 5.5).

5.1 Phase I – Identification (Pre-concept)

This phase includes the activities of defining the needs and opportunities. The outcome is a needs and opportunity statement. Where a pre-concept study is undertaken (for major projects)

COMS should be part of the consideration in the study. For small projects, the needs assessment might not involve COMS considerations.

During this phase the Initiator completes a high level COMS review using "Appendix B – COMS Summary Checklist". The size of the COMS team used to complete the COMS review is dependent on the size of the project. The results of the review are recorded on the COMS Summary Checklist – Appendix B and any issues are recorded on the COMS Action Plan – Appendix C. All items on the COMS Action Plan – Appendix D must be disposed of or carried over to the next Phase. Upon completion, the Initiator signs and dates the COMS Action Plan – Appendix D.

5.2 Phase II – Initiation (Concept)

This phase includes the activities of preparing concept studies and developing a Project Charter base on preferred alternative. The outcome of this phase is the concept study and the Project Charter with consideration of COMS.

During this phase the Design Team Lead completes a high level COMS review using COMS Summary Checklist – Appendix B. The size of the COMS team used to complete the review is dependent on the size and complexity of the project. The results of the review are recorded on the checklist and any issues are recorded on the COMS Action Plan – Appendix D. All items on the COMS Action Plan – Appendix D must be dispositioned of or carried over to the next Phase. Upon completion, the Design Team Leader signs and dates the COMS Action Plan – Appendix D.

5.3 Phase III – Definition

This phase includes Scoping of the project, preparing the requirements (performance and functional), preparing the Project Execution Plan, Preparing the RFP/Tender, conducting a bid evaluation, and selecting the Design Build Contractor. The outcome in this phase is the completion of the COMS Detailed Checklist – Appendix C, COMS Action Plan – Appendix D.

During this phase of the project, Design Team Leader or the Design Build Contractor's Design Team Leader completes the COMS Detailed Checklist – Appendix C and performs the

preliminary design. As part of the Definition Phase, a COMS Review is recommended. The size of the COMS Review Team used to complete the review is dependent on the size and complexity of the project. The results of the review are recorded on the checklist and any issues are recorded on the COMS Action Plan – Appendix D. All items on the COMS Action Plan – Appendix D must be disposed of or carried over to the next Phase. Upon completion, the Design Team Leader or Design Build Contractor signs and dates the COMS Action Plan – Appendix D.

The Design Team Leader should check COMS database (to be set up) for similar design to learn from previous experience.

5.4 Phase IV – Execution

This phase includes the project kick-off meeting, detailed design (Design, Drawings & Technical Specs), Construction/Installation/Removal and Commissioning. During the detailed design, the design team will address the issues/risks identified during the Definition Phase. During the detailed design phase, and depending on the project plan, a design review is carried out at 30% or 50% stage of the design. A COMS Review is performed in conjunction with the design review. The Size of the COMS Review Team used to complete the review is dependent on the size and complexity of the project. Specialists are brought in to ensure the proper input is provided. The outcome of this phase is the completion of the COMS Detailed Checklist – Appendix C, COMS Action Plan – Appendix D, and Design Build Contractor COMS Action Plan – Appendix D and turn-over to the client. The results of the review are recorded on the checklist and any issues are recorded on the COMS Action Plan – Appendix D. All items on the COMS Action Plan – Appendix D must be disposed of or carried over to the next Phase. Upon completion, the Design Team Leader or Design Build Contractor signs and dates the COMS Action Plan – Appendix D.

5.5 Phase V – Close-out

During the Close-out phase, COMS helps identify lessons learned and COMS issues that could not be dispositioned. Design Team Lead and COMS Facilitator will review the COMS activities during the project and

- Identify and record any lessons learned
- Record any low risk COMS issues that were not dispositioned during the previous phases of the project.

COMS Report (lessons learned) is passed on to the process owner for consideration during the next revision of the process and the COMS issues are passed on to the Asset Manager for consideration during future modification of the system.

6. RECORDS

All COMS records for each project whether they are compiled by the individual designer or by the team should be kept as part of the project documents. These include:

- Completed COMS Summary Checklists – Appendix B (HED-FRM-CO-001)
- Completed COMS Detailed Checklists – Appendix C (HED-FRM-CO-002)
- COMS Project Action Plan – Appendix D (HED-FRM-CO-003)

All the COMS documentation should be compiled into a COMS Report and be included as part of the Project Turnover documents

APPENDIX 1 – COMS PROCESS MATRIX (SEE NOTE 1)

Project Phase	Project Activities & Deliverables	COMS Activities	Responsibility	COMS Tool	COMS Deliverables
Phase I Identification (Pre-concept)	Define needs/opportunities	Initiator has COMS awareness; identify COMS opportunities; takes COMS into account in decision and recommendations.	Project initiator.	COMS Summary Checklist – Appendix B.	Needs and opportunities statement
Phase II Initiation (Concept)	Prepare Concept Studies; Develop Project Charter based on preferred alternative.	Consider COMS while performing concepts and option designs; Fill out COMS checklist and prepare high level COMS related actions or requirements; transfer to Definition Phase III.	Responsible Engineer or Engineering Team performing Concept Studies.	COMS Summary Checklist – Appendix B.	Concepts & associated COMS Action Plan – Appendix D; Charter for Definition Phase with COMS requirement noted
Phase III Definition	Scoping Project Requirements; Preparation of User Requirements document (Performance/Functional Specs) Project Execution Plan.	Consider COMS while scoping User Requirements and preparing preliminary design and layout; document same Develop a COMS Plan as part of PEP/Engineering Plan (Engineering Plan being a subset of PEP).	Responsible Engineer or Engineering Team.	COMS Detailed Checklist – Appendix C.	Preliminary design with COMS consideration COMS in User Requirements & COMS Action Plan – Appendix D Project & Engineering Plan with COMS activities identified.
	RFP/Tendering, Bid Evaluation/Contactor Selection.	Build COMS as part of tendering submission requirements; Bid Evaluation & Contractor selection include quality of COMS Plan submission.	Project Manager or responsible Engineer with input from Supply Chain.	N/A	Design Build Contractor COMS Action Plan - Appendix D submission in Tender and OPG Tender Evaluation.

Project Phase	Project Activities & Deliverables	COMS Activities	Responsibility	COMS Tool	COMS Deliverables
Phase IV Execution	Detailed Design (Design, Drawings & Technical Specs).	Formal (detailed) COMS Review at 30% or 50% completion of design; Apply the COMS Action Plan to finalize design.	Design Engineer; followed by Formal Review Team.	Detailed COMS Checklist – Appendix C covering COMS.	Design addressing COMS COMS Review documentation and COMS Action Plan – Appendix D
	Construction-Installation.	Design Changes during construction need to go through COMS check; build into Project Change Control approval process and document.	Design or site Engineers; followed by Formal Review Team.	Use latest COMS Action Plan – Appendix D for reference.	Project change control approval
	Commissioning.	Perform COMS walkdown as part of Acceptance walkdown/process; Check against COMS Action Plan as checklist; disposition outstanding COMS issues; document non-design 'residuals' follow-ups required.	Design Engineer; followed by Formal Review Team.	Use latest COMS Action Plan – Appendix D for reference.	Updated COMS Action Plan – Appendix D identifying residual risk and actions
Phase V Close out	Project Turn-over.	Prepare COMS Report as part of Turn- over document.	Design Engineer/Project Engineer.	Final COMS Action Plan – Appendix D.	COMS Report

Note 1: Activities and deliverables associated with the different Phases of a project might vary. Align table with the user's specific application.

APPENDIX 2 – COMS SUMMARY CHECKLIST (SAMPLE)

Note: COMS Summary Checklist (HED-FRM-CO-001) is available under Governing Documents/Forms on the HED Web page

COMS SUMMARY CHECKLIST

#	Are there safety and other issues related to the following items?	Construction Installation Removal				Operations				Maintenance			
		Yes	No	NA	Action #	Yes	No	NA	Action #	Yes	No	NA	Action #
1	Legal Issues												
2	Geological Surveys												
3	Utilities												
4	Lodging												
5	Public/Stakeholders												
6	Environmental												
7	Workforce												
8	Physical Arrangement												
9	Process Planning												
10	Safety												
11	Posture												
12	Static Posture												
13	Manual Material Handling (MMH) - lift, lower, push, pull, carry												
14	Gripping												
15	Repetition - tasks that require constant movement of body parts with little or no break												
16	Human Factors/Ergonomics												
17	Security												
18	Emergency Response												
19	Others (Specify)												

Note: This form should be completed in accordance with HED-MAN-008, COMS Guide

APPENDIX 3: COMS DETAILED CHECKLIST (SAMPLE)

Note: COMS Detailed Checklist is available under Governing Documents/Forms on the HED Web page

COMS DETAILED CHECKLIST

(To be completed in accordance with HED-MAN-008, COMS Guide)

#	Are there safety and other issues related to the following items?	Construction Installation Removal				Operations				Maintenance			
		Action required				Action required				Action required			
		Yes	No	NA	Action #	Yes	No	NA	Action #	Yes	No	NA	Action #
1	**Legal issues**												
1.1	Are there land rights that need to be addressed?												
1.2	Are there property issues that need to be addressed?												
1.3	Are there any restrictions, such as Land use?												
2	**Geological Surveys**												
2.1	Is a geological survey required?												
3	**Utilities**												
3.1	Availability of electricity at the workplace.												
3.2	Availability of gas at the workplace.												
3.3	Availability of water at the workplace.												
3.3	Availability of communications at the workplace.												
3.4	Availability of sewers at the workplace.												
3.5	Relocation of permanent services.												
4	**Lodging**												
4.1	Availability of lodging near the site.												
5	**Public/Stakeholders**												
5.1	Visibility of work activities to the public.												
5.2	Perception by the public.												
5.3	Need for public involvement.												
5.4	Is there a need to minimize direct impact to the public?												
5.5	Is there a need for public relations activities?												
6	**Environmental**												
6.1	Are environmental permits required?												
6.2	Is an environmental assessment/study required?												

6.3	Is a new/revision of a Certificate of Approval (C of A) required?													
6.4	Are there non-hazardous waste products?													
6.5	Are there hazardous waste products?													
6.6	Is there an opportunity for the escape of contaminants and petrochemical products into the environment (air, effluent, solid, liquid waste, fuels, oils)?													
6.7	Is there a possibility of noise, dust, spills to the lake?													
6.8	Is there any impact on neutralized areas, intake, outfall, and shoreline?													
6.9	Is there an opportunity to minimize energy use?													
6.10	Are there alterations to the aquatic environment (fisheries issues)?													
6.11	Are there land alterations, habitat and land use?													
6.12	Are there changes to land area, water courses and/or water levels?													
6.13	Is there a possibility of affecting plant and wildlife?													
6.14	Is there a possibility of affecting sensitive or special species (e.g. plant and wildlife)?													
7	**Workforce**													
7.1	Are there barriers to communications between the workers?													
7.2	Are there issues with communication devices (e.g. cell phones)?													
7.3	Are there language issues (oral/written)?													
7.4	Can the need for specific education/training of workers be minimized?													
7.5	Can the need for specific qualification or certifications of workers be minimized?													
7.6	Can the need for special labour skills be minimized?													
8	**Physical Arrangement**													
8.1	Are there restrictions to plant layout (can you physically put it where you want it)?													
8.2	Are there restrictions to equipment layout (can you physically put it where you want it?)													
8.3	Is there an opportunity to optimize workflow?													
8.4	Is the equipment, system too close to other systems, structures and components (interference or restrictions)?													
8.5	Is there lack of accessibility for personnel?													
8.6	Is there lack of accessibility for equipment?													

8.7	Is there lack of space for equipment laydown?													
8.8	Are there concerns with interface between existing or proposed structures, systems, or components?													
8.9	Is the work to be performed in a poor environment (temperature, weather)?													
8.10	Are there any significant constraining structural capacity requirements?													
8.11	Is there process noise that may interfere with required communications?													
8.12	Availability of infrastructure at the immediate work site (e.g. drains, air, electrical, water, fuels).													
8.13	Is the process or equipment located in an area where leaks or condensation are likely?													
8.14	Will work involve the disturbance and removal of insulation?													
8.15	Will the work affect general or local ventilation?													
8.16	Will the work change the use of building or floor area impact fire – resistant rating of any fire separation, creating fire hazards exceeding the criteria for which the fire protection system were designed?													
8.17	Will the work affect fire zones ratings (e.g. cable routing or piping work)?													
8.18	Will the work affect existing lighting or signs?													
8.19	Will the work affect the accessibility of fire zone by fire-fighters from municipal fire department (fire routes) or from Emergency Response team?													
9	**Process/Planning**													
9.1	Is the schedule for the work a factor (time of year, inside/outside work, outage, non-outage?													
9.2	Does the design restrict alternative or various construction methods?													
9.3	Is there opportunity for pre-fabrication or modularity?													
9.4	Are there potential conflicts with tasks, activities, or crews (sequencing and coordination)?													
9.5	Availability of design documents prior to the start of work.													
9.6	Availability of spare parts.													
9.7	Can we eliminate/minimize special techniques, tools, or support equipment?													
9.8	Is performance of complex or potentially dangerous tasks under time and pressure constraints?													

9.9	Adequacy and availability of information needed for the task.													
10	**Safety**													
10.1	Can we eliminate or minimize chemical hazards?													
10.2	Can we eliminate or minimize designated substances s?													
10.3	Can we disturb designated substances (e.g. lead, asbestos)													
10.4	Can we eliminate or minimize confined space hazards?													
10.5	Can we eliminate or minimize craning and rigging hazards?													
10.6	Can we eliminate or minimize drilling/cutting/breaking the surface hazards?													
10.7	Can we eliminate or minimize driving hazards?													
10.8	Can we eliminate or minimize electrical contact hazards?													
10.9	Can we eliminate or minimize electrical arc flash hazards?													
10.10	Can we eliminate or minimize mechanical hazards?													
10.11	Can we eliminate or minimize excavation hazards?													
10.12	Can we eliminate or minimize falling (people) hazards?													
10.13	Can we eliminate or minimize flying/falling objects hazards?													
10.14	Can we eliminate or minimize flammable (fire) or combustible hazards (explosion)?													
10.15	Can we eliminate or minimize material handling?													
10.16	Can we eliminate or minimize noise and vibration hazards?													
10.17	Can we optimize use of power tools?													
10.18	Can we eliminate or minimize pressurized fluids, gases, steam, cryogenics, etc.?													
10.19	Can we eliminate or minimize traffic hazards (vehicle/pedestrian)?													
10.20	Can we optimize the use of transport work equipment?													
10.21	Can we eliminate or minimize the transportation of dangerous goods?													
10.22	Can we eliminate or minimize working near or open waterways?													
10.23	Can we eliminate or minimize welding/cutting hazards?													
10.24	Adequacy of guarding.													
10.25	Adequacy of the ability to isolate for permitry?													
10.26	Can we eliminate or minimize work in extreme hot or cold temperature?													
10.27	Are there electrical grounding and bounding requirements?													
10.28	Will the work involve the removal of paint (using a torch or grinding), form the system or its components?													
11	**Postures**													

11.1	Is the person required to work with their hand(s) at a vertical height of 76 cm (30 inches) or less from the ground?												
11.2	Is the person required to work with their hand(s) at a vertical height of 127 cm (50 inches) or greater from the ground?												
11.3	Will horizontal reach to the work be at a distance of 61 cm (24 inches) or greater, in front of the person?												
11.4	Will horizontal reach to the work be at a distance of 61 cm (24 inches) or greater, to the side of the person?												
11.5	Does the work require the person to reach across the midline of their torso?												
11.6	Does the work require the person to reach behind their torso?												
11.7	Does the work require the hands to assume awkward postures (i.e. not in the 'handshake' position)?												
12	**Static Postures**												
12.1	Are any individual exertions held for >10 seconds at a time (i.e. a single reach, or forward lean)?												
12.2	Does the work require the person to perform tasks in the same position for >1 hour at a time?												
13	**Manual Material Handling (MMH) - lift, lower, push, pull, carry**												
13.1	Does two-handed MMH occur with loads > 10 kg (22 lb)?												
13.2	Does one-handed MMH occur with loads > 5 kg (11 lb)?												
13.3	Are the loads that are to be handled awkward (i.e. uneven weight distribution, no hand-holds)?												
13.4	Is any type of MMH required while working on a gradient (i.e. uphill vs. downhill vs. side gradient)?												
14	**Gripping**												
14.1	Does gripping occur on tools/objects/handles with span unequal to 5 cm in diameter?												
14.2	Does the person exert a pinch grip (grip span <5 cm) on objects weighing >1 kg?												
14.3	Does the person exert a power grip (grip span = 5 cm) on objects weighing >5 kg?												
15	**Repetition - tasks that require constant movement of body parts with little or no break**												
15.1	Are there tasks that require the person to perform forearm/hand/finger motions at >10 motions per minute (i.e. operating controls, manual torquing of fasteners)?												

15.2	Are there tasks that require the person to perform shoulder motions at >2 motions per minute (i.e. reaching to operate controls)?												
15.3	Are there tasks that require the person to move the torso at >2 motions per minute (i.e. leaning in any direction, twisting)?												
15.4	If there is a designated cycle time to perform the work, is 50% of it performed in similar postures (i.e. leaning forward, or to the side)?												
16	**Human Factors**												
16.1	Will the person be exposed to sources of vibration at the hand (i.e. drills, boring equipment, chipping hammers)?												
16.2	Will the person be exposed to sources of whole body vibration (i.e. seated while operating machinery/mobile equipment)?												
16.3	Are there tool/machine/equipment edges with which the person will come in contact?												
16.4	Is the person required to use the hand or other body part as a "hammer"?												
16.8	Is there information needed for the task which is not readily available?												
16.9	Performance of complex or potentially dangerous tasks under time and pressure?												
16.10	Performance of tasks requiring alertness or concentration in an area with annoying noises or distractions?												
16.11	Is there a potential for human error related to controls, displays, communication, warnings, labels, instructions, information, visibility?												
16.12	Are performances of tasks requiring divided attention between two or more signals or displays?												
16.13	Are performances of tasks requiring the detection of alarms and signals?												
16.14	Are there operating controls or displays which may not meet Human Factors Guidelines?												
17	**Emergency Response**												
17.1	Availability of resources available to deal with any emergency?												
17.2	Availability of space for a response to the emergency.												
17.3	Emergency routes, exits and emergency lighting for an evacuation.												
17.4	Availability of resources for a rescue during an emergency situation.												
17.5	Is seismic monitoring required?												

17.6	Availability of emergency plans.													
18	**Other (specify)**													

APPENDIX 4: COMS ACTION PLAN

COMS ACTION PLAN

Project Number:		Project Title:						
Phase (circle appropriate phase)			I	II	III	IV	V	Date:

COMS Review Team (Team Members Initial their Expertise)				
COMS Facilitator	Design Team Leader	Design Team	Conventional Safety	Ergonomist
Human Factors Engineer	Industrial Hygienist	Environmental Specialist	Construction Worker	Operator
Maintainer	Other			

*a= eliminating issues/risks out right through design concept change (e.g. moving pipe/meter location; b= mitigate thru design-out (e.g. railings); c= administrative/procedural means required to be incorporated; d= low risks items to be addressed in the future

Action Plan #	COMS Area (Constructability, Operability, Maintainability)	Issue/Risk	Disposition Means	*a,b,c,d	Accountabilities	Target Completion Date	Status

Action Plan #	COMS Area (Constructability, Operability, Maintainability)	Issue/Risk	Disposition Means	*a,b,c,d	Accountabilities	Target Completion Date	Status

Design Team Leader/Initiator

Project Manager/Engineer

Design Build Contractor

APPENDIX 5: ACRONYMS

Acronyms	
BCS	Business Case Summary
C of A	Certificate of Approval
PEP	Project Execution Plan
RFP	Request for Proposal
SME	Subject Matter Experts