**OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
ANALYSIS/MODEL COVER SHEET**

1. QA: N/A
Page: 1 of: 15

Complete Only Applicable Items

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2. ☒ Analysis ☒ Engineering
☐ Performance Assessment
☐ Scientific

3. ☐ Model ☐ Conceptual Model Documentation
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OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
ANALYSIS/MODEL REVISION RECORD

1. Page: 2 of: 15

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4. Revision/Change No.	5. Description of Revision/Change
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1. PURPOSE

The purpose and objective of this analysis is to structurally evaluate the existing Exploratory Studies Facility (ESF) mine power center (MPC) support frames and to design service platforms that will attach to the MPC support frames. This analysis follows the Development Plan titled *Produce Additional Design for Title III Evaluation Report* (CRWMS M&O 1999a).

This analysis satisfies design recommended in the *Title III Evaluation Report for the Surface and Subsurface Power System* (CRWMS M&O 1999b, Section 7.6) and concurred with in the "System Safety Evaluation of Title III Evaluation Reports Recommended Work" (Gwyn 1999, Section 10.1.1).

This analysis does not constitute a level-3 deliverable, a level-4 milestone, or a supporting work product. This document is not being prepared in support of the Monitored Geologic Repository (MGR) Site Recommendation (SR), Environmental Impact Statement (EIS), or License Application (LA) and should not be cited as a reference in the MGR SR, EIS, or LA.

2. QUALITY ASSURANCE

No Quality Assurance (QA) Controls are applicable to the items or activities addressed in this design analysis. The items addressed in this analysis are temporary and therefore have not been classified in accordance with QAP-2-3. There are no Determination of Importance Evaluation (DIE) Controls associated with the support frames and service platforms covered in this analysis (CRWMS M&O 1999c). A QAP-2-0 evaluation has been completed (CRWMS M&O 1998a) and determined to not be subject to the *Quality Assurance Requirements and Description for the Civilian Radioactive Waste Management Program* (QARD) (DOE 1998). QA: N/A.

3. COMPUTER SOFTWARE AND MODEL USAGE

STAAD-III (STAAD-III V22.3a, 30024 V22) structural analysis and design software is used in this analysis. The computer software is not supporting an analysis subject to the requirements of the QARD (DOE 1998) (see Section 2) and therefore does not need to be qualified.

4. INPUTS

4.1 DATA AND PARAMETERS

4.1.1 Height of invert = 24 15/16" (CRWMS M&O 1994, Section A) (Section 6.2)

4.1.2 Weight of low voltage section = 12000 lbs; Weight of medium voltage section = 8000 lbs (CRWMS M&O 1995, p. 101) (Section 6.2)

- 4.1.3 Weight per square foot of KORDEK RKD 1.0 fiberglass grating = 3.15 lb/ft²
(International Grating 1999) (Section 6.3)

4.2 CRITERIA

The following criteria were developed to respond to the requirements presented in the *Exploratory Studies Facility Design Requirements* (YMP 1997) that specifically apply to this analysis. The applicable requirements are cited for each statement.

- 4.2.1 The permanent and temporary items of the ESF shall be designed to withstand the applicable seismic environment specified in Appendix A (YMP 1997, Section 3.2.1.2.1.2.A). The MPC support frames and service platforms are designed to withstand the 0.3 g seismic event specified for temporary subsurface facilities in Appendix A and consistent with Zone 3 of the *Uniform Building Code* (UBC) (ICBO 1997). (Sections 6.1, 6.2 & 6.3)
- 4.2.2 The ESF non-permanent items shall be designed for a 25-year maintainable service life (YMP 1997, Section 3.2.1.2.2.A). The MPC support frames and service platforms are composed of steel and fiberglass and will be monitored through the Operation and Maintenance (O&M) phase of the ESF. (Section 6.1)
- 4.2.3 The ESF shall be designed in compliance with the applicable requirements in the *Uniform Building Code* (YMP 1997, Section 3.2.1.2.4.A). The MPC support frames and service platforms are designed to withstand a 0.3 g seismic event consistent with Zone 3 of the UBC (ICBO 1997) and follow the load combination design approach stipulated in the UBC. (Sections 6.1, 6.2 & 6.3)
- 4.2.4 Utility lines, steel supports, and other conducting structures supporting electrical systems shall be electrically bonded and reliably connected to the subsurface electrical safety grounding network (YMP 1997, Section 3.8.2.2.1.O). The existing MPC support frames are currently connected to the grounding network and the new service platforms will be bonded to the existing frames. (Section 6.1)
- 4.2.5 The underground material and personnel handling systems shall be sufficiently sized to sustain construction, operations, and testing (YMP 1997, Section 3.8.4.4.1.B). The revised transportation corridor allows adequate clearance for the anticipated equipment typically used on a daily basis. (Section 6.1)

4.3 CODES AND STANDARDS

4.3.1 American Institute of Steel Construction (AISC)

AISC 1995

*Manual of Steel Construction Allowable Stress Design
Ninth Edition*

4.3.2 American Society for Testing and Materials (ASTM)

ASTM A36/A36M-97a	<i>Standard Specification for Carbon Structural Steel</i>
ASTM A307-97	<i>Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength</i>
ASTM A563-97	<i>Standard Specification for Carbon and Alloy Steel Nuts</i>
ASTM F436-93	<i>Standard Specification for Hardened Steel Washers</i>
ASTM F1267-91	<i>Standard Specification for Metal, Expanded, Steel</i>

4.3.3 American Welding Society (AWS)

AWS D1.1:2000	<i>Structural Welding Code - Steel</i>
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4.3.4 International Conference of Building Officials (ICBO)

ICBO 1997	<i>Uniform Building Code</i>
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4.3.5 National Fire Protection Association (NFPA)

NFPA 70-98	<i>National Electrical Code 1999 Edition</i>
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4.3.6 American National Standards Institute (ANSI)

ANSI Z535.2-1998	<i>Environmental and Facility Safety Signs</i>
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5. ASSUMPTIONS

Not Used

6. ANALYSIS/MODEL

6.1 INTRODUCTION

Access to the existing MPCs in the ESF is currently provided by ladders stored at the base of the MPC support frames. A recommended safety enhancement to install service platforms to the support frames was made in CRWMS M&O 1999b, Section 7.6. These service platforms with fixed ladders will also meet the "readily accessible" requirements of NFPA 70-98, Sections 110-33, 240-24, 380-8, 430-107, and 450-13.

The typical MPC consists of two individual sections: 1) a 480 V (277 V to ground) low voltage section with a 12.47 kV to 480 V transformer, and 2) a 12.47 kV (7.2 kV to ground) medium voltage section. Per NFPA 70-98, Tables 110-26(a) and 110-34(a), the minimum working spaces for 277 V to ground and 7.2 kV to ground are 3 feet and 4 feet, respectively, under Condition 1 (exposed live components on one side of a space and no live or grounded parts on the other side). Condition 1 will be achieved by utilizing fiberglass grating and handrails in the service platform design. To achieve the minimum encroachment into the existing ESF transportation corridor, a 3 foot wide platform can be used if the 4 foot work space requirement for the higher voltage is mitigated by de-energizing all 12.47 kV equipment before work is performed. Signs meeting the requirements of ANSI Z535.2 shall be prepared stating "DANGER DE-ENERGIZE 12.47 kV POWER BEFORE SERVICING" and shall be posted on each individual MPC section.

Although intrusion into the existing transportation corridor by the new platforms will not interrupt daily tunnel operations (see "Clearance", Attachment I, p. I-2), the Construction Management Organization (CMO) may opt to implement administrative controls such as limiting the speed of the locomotives as they pass the MPC platforms. The CMO does need to implement administrative controls to evaluate any wide loads entering the tunnel in order to ensure clearance between the new platforms and the loads. If clearance is not adequate, the platforms will need to be temporarily removed and then replaced following passage of the loads. Although labor intensive, this activity will be a very infrequent event in the O&M phase of the ESF. Aside from this anomalous event, the revised horizontal transportation corridor (Attachment I, p. I-2) is adequately sized to meet the anticipated needs of construction, operations, and testing (Criterion 4.2.5).

The existing support frames are currently connected to the grounding network. The service platform support steel will be required to be electrically bonded to the existing frames (Criterion 4.2.4). The use of steel and fiberglass materials as well as monitoring through the O&M phase of the ESF will ensure that the MPC support frames and service platforms meet the 25-year maintainable service life (Criterion 4.2.2).

Two design cases are analyzed using STAAD-III computer software. The structural adequacy of the existing support frames is analyzed in Section 6.2. The new service platform design is analyzed in Section 6.3. Both design cases follow the allowable stress design load combinations in the UBC, Section 1612.3.1 (ICBO 1997) (Criterion 4.2.3) and are designed to withstand a 0.3 g seismic force, consistent with Zone 3 of the UBC (ICBO 1997, Table 16-I) (Criteria 4.2.1 and 4.2.3).

6.2 EXISTING MPC FRAME ANALYSIS

Existing MPC frame information is shown in Attachment I, p. I-2. To calculate the loads on the existing frame, the maximum bay width span of 84" will be used. The STAAD-III input file for the existing frame is shown in Attachment II, page II-2, and analyzes the following frame:

JOINT	COORD	SUPPORT
1	(0, 0)	PIN
2	(-3.167, 0)	-
3	(-4.0, 0)	-
4	(-3.167, -4.583)	PIN

Calculate loads used in input file:

Weight of low voltage section = 12000 lbs (CRWMS M&O 1995, p. 101) (Parameter 4.1.2)

Weight of medium voltage section = 8000 lbs (CRWMS M&O 1995, p. 101) (Parameter 4.1.2)

Each section sits on S8x23 skids which span across the C6s.

Max MPC wt/ft per C6 = 12000/14'/2 = 428.6 lb/ft

Wt/ft² of 3/4 number 9 expanded metal = 1.80 lb/ft² (ASTM F1267-91, Table 1)

Exp. metal wt/ft per C6 = (1.80)(4')/2 = 3.6 lb/ft

Total uniform load = 428.6+3.6+10.5 (wt/ft of C6) = 442.7 lb/ft, say 450 lb/ft

Point loads from the L3 intermediate support braces can be ignored since the total uniform load has been conservatively increased.

For simplicity, conservatively use total uniform load across all 4 bays:

$R_{max} = 1.143\omega l$ (AISC 1995, p. 2-309) at second and fourth supports = (1.143)(450)(7') = 3600 lbs applied at joints 1 & 3

Uniform load across members ① & ② = wt/ft of C6 = 10.5 lb/ft

STAAD-III load combination 11 = D + E/1.4 (ICBO 1997, Section 1612.3.1, Equation 12-9) (Criterion 4.2.3) = D + 0.3D (Criterion 4.2.1) /1.4 = D + 0.214D

Per the STAAD-III output file for the existing frame shown in Attachment II, p. II-4, all members are adequate.

Check bending across C6 span:

$\omega_{max} = (1.214)(450) = 546.3 \text{ lb/ft}$

$M_{max} = 0.1071\omega l^2 = (.1071)(546.3)(7')^2 = 2867 \text{ lb-ft}$

$S_x = 5.06 \text{ in}^3$ (AISC 1995, p. 1-41)

$f_b = M/S = (2867)(12)/5.06/1000 = 6.8 \text{ ksi} < F_b = 0.60F_y$ (AISC 1995, Equation F1-5) = (.60)(36) = 21.6 ksi $\therefore$ OK

L3x3x3/16 intermediate braces only support the expanded metal grating and are adequate by inspection.

Check Split Set anchorage:

SS-39 Split Sets are rated for $(24000)(0.1606) = 3850$ lbs shear (CRWMS M&O 1998b, Section 5.3) and have been pull tested in the ESF to over 8000 lbs tension with minimal displacement (YMP 1998). Checking the output file, joint 4 under the combined loading yields the highest support reactions: $F_y = 5166$ lbs & $F_x = -357$ lbs

Calculate relative angle between global and Split Set axes using circle properties (AISC 1995, p. 6-16):

$$r = 12.5'$$

$$\text{Ht of invert} = 24 \frac{15}{16}" \text{ (CRWMS M\&O 1994, Section A) (Parameter 4.1.1) } = 24.94"$$

$$b = (\text{Ht of frame above invert} - \text{Ht of frame}) + \text{Ht of invert} = (75" \text{ (Attachment I, p. I-2) } - 65" \text{ (Attachment I, p. I-4)}) + 24.94" = 34.94"/12 = 2.91'$$

$$b = 2r \sin^2(A/4) \Rightarrow A^\circ = 4[\sin^{-1}(2.91/2/12.5)^{1/2}] = 79.8^\circ \Rightarrow A/2 = 79.8/2 = 40^\circ$$

$$F_{C(y)} = F_y \cos(A/2) = 5166 \cos(40) = 3957.4 \text{ lbs}$$

$$F_{V(y)} = F_y \sin(A/2) = 5166 \sin(40) = 3320.6 \text{ lbs}$$

$$F_{C(x)} = F_x \sin(A/2) = 357 \sin(40) = 229.5 \text{ lbs}$$

$$F_{V(x)} = F_x \cos(A/2) = -357 \cos(40) = -273.5 \text{ lbs}$$

$$\text{Net } F_C = 3957.4 + 229.5 = 4187 \text{ lbs} \Rightarrow \text{plate will take compression} \therefore \text{OK}$$

$$\text{Net } F_V = 3320.6 - 273.5 = 3047 \text{ lbs} \Rightarrow 3047/2 \text{ bolts} = 1524 \text{ lbs/bolt} < 3850 \text{ lbs} \therefore \text{OK}$$

Joint 1 will have tension on bolts and is OK by inspection.

The existing MPCs need to be attached to the support frames (NFPA 70-98, Section 110-13.(a)). Try (4) ASTM A307 5/8" ϕ bolts per MPC section:

Max. shear = horizontal seismic load = $(0.3)(12000)/4 \text{ bolts} = 900 \text{ lbs/bolt} < \text{allowable shear} = 3.1 \text{ kips/bolt}$ (AISC 1995, Table I-D) $\therefore$ OK

Maximum flange fastener size = 3/4" (AISC 1995, p. 1-36) $\therefore$ OK

The existing MPC frame at Station 20+00 m is the only frame in the ESF that varies significantly from the generic design analyzed (see Attachment I, page I-2). It uses smaller beam/column members (W6x9 rather than W6x15), has a smaller span (72" rather than 84"), and supports a much lighter MPC section (5000 lbs rather than 12000 lbs). Reviewing the generic design results, the highest interaction ratio = 0.222 (Attachment II, page II-4). Taking into account the smaller span, lighter loads, and low interaction results of the generic design, the smaller frame members are approved by inspection. However, the column base plates need to be anchored to the concrete floor.

The existing frames are adequate as-constructed to support the MPCs and to sustain a design seismic event.

6.3 MPC PLATFORM ANALYSIS

The new working platform information is shown in Attachment I, pp. I-3 & I-4. The platform consists of box frame with similar members as the existing box frame, attached to the existing frame. Three L3x2x3/16 members were chosen as knee braces to support the outer edge of the platform at the center and both ends of the platform. All steel shall conform to ASTM A36. KORDEK RKD 1.0 fiberglass grating as manufactured by International Grating, Inc. was chosen for the working platform since it has a maximum safe load of 800 lbs/ft² (International Grating 1999). The STAAD-III input file for the existing frame and new platform is shown in Attachment II, p. II-5, and analyzes the following frame:

Calculate loads used in input file:

Wt/ft² of KORDEK RKD 1.0 fiberglass grating = 3.15 lb/ft² (International Grating 1999)
(Parameter 4.1.3)

Grating wt/ft per C6 = (3.15)(3')/2 = 4.73 lb/ft

Total uniform dead load = 4.73+10.5 (wt/ft of C6) = 15.23 lb/ft, say 25 lb/ft to allow for fiberglass handrail and toe plate.

Point loads from the L3 intermediate support braces can be ignored since the total uniform load has been conservatively increased.

$R_{max} = (10/8)\omega l$ (AISC 1995, p. 2-312) at middle support = (1.25)(25)(14') = 438 lbs, say 440 lbs applied at joints 3 & 4

Calculate loads on existing frame at middle support:

$R_{middle} = 0.928\omega l$ (AISC 1995, p. 2-309) = (0.928)(450)(7') = 2923.2 lbs, say 2925 lbs applied at joints 1 & 3

Total dead load at joint 3 = 440+2925 = 3365 lbs

STAAD-III load combination 12 = D + E/1.4 (ICBO 1997, Section 1612.3.1, Equation 12-9)
(Criterion 4.2.3) = D + 0.3D (Criterion 4.2.1) / 1.4 = D + 0.214D

In addition, a 125 psf live load is applied to the new platform (ICBO 1997, Section 1607, Table 16-A, Category 9, Heavy):

Wt/ft LL per C6 = (125)(3')/2 = 187.5 lb/ft

$R_{max} = 1.25\omega l = (1.25)(187.5)(14') = 3281.3$ lbs, say 3285 lbs applied at joints 3 & 4

STAAD-III load combination 11 = D + L (ICBO 1997, Section 1612.3.1, Equation 12-8)

STAAD-III load combination 13 = D + 0.75[L + E/1.4] (ICBO 1997, Section 1612.3.1, Equation 12-11) = D + 0.75L + 0.161D

Per the STAAD-III output file for the existing frame and new platform shown in Attachment II, p. II-9, all members are adequate.

Check bending across C6 span:

Max loading combination = D + L

$$\omega_{\max} = 25 + 187.5 = 212.5 \text{ lb/ft}$$

$$M_{\max} = 0.125\omega l^2 = (.125)(212.5)(14')^2 = 5206.3 \text{ lb-ft}$$

$$S_x = 5.06 \text{ in}^3 \text{ (AISC 1995, p. 1-41)}$$

$$f_b = M/S = (5206.3)(12)/5.06/1000 = 12.35 \text{ ksi} < F_b = 0.60F_y \text{ (AISC 1995, Equation F1-5)}$$

$$= (.60)(36) = 21.6 \text{ ksi} \therefore \text{OK}$$

Check L3x3x3/16 intermediate braces:

$$\omega_D = (3.15 \text{ psf})(2.333') = 7.35 \text{ lb/ft}$$

$$\omega_L = (125 \text{ psf})(2.333') = 291.63 \text{ lb/ft}$$

$$\omega_{D+L} = 7.35 + 291.63 = 299 \text{ lb/ft}$$

$$M_{\max} = \omega l^2/8 \text{ (AISC 1995, p. 2-296)} = (299)(3')^2/8 = 336.4 \text{ lb-ft}$$

$$S_x = 0.441 \text{ in}^3 \text{ (AISC 1995, p. 1-49)}$$

$$f_b = M/S = (336.4)(12)/.441/1000 = 9.2 \text{ ksi} < F_b = 21.6 \text{ ksi} \therefore \text{OK}$$

Check Split Set anchorage:

Checking the output file, joint 6 under load combination 11 yields the highest support reactions: $F_y = 11420 \text{ lbs}$ & $F_x = -3749 \text{ lbs}$

$$F_{C(y)} = F_y \cos(A/2) = 11420 \cos(40) = 8748 \text{ lbs}$$

$$F_{V(y)} = F_y \sin(A/2) = 11420 \sin(40) = 7341 \text{ lbs}$$

$$F_{C(x)} = F_x \sin(A/2) = 3749 \sin(40) = 2410 \text{ lbs}$$

$$F_{V(x)} = F_x \cos(A/2) = -3749 \cos(40) = -2872 \text{ lbs}$$

$$\text{Net } F_C = 8748 + 2410 = 11158 \text{ lbs} \Rightarrow \text{plate will take compression} \therefore \text{OK}$$

$$\text{Net } F_V = 7341 - 2872 = 4469 \text{ lbs} \Rightarrow 4469/2 \text{ bolts} = 2235 \text{ lbs/bolt} < 3850 \text{ lbs (CRWMS M\&O 1998b)} \therefore \text{OK}$$

Joint 1 will have tension on bolts and is OK by inspection.

Design attachment at joint 3:

$$D + L = 440 + 3285 = 3725 \text{ lbs vertical load at joint.}$$

Check L3x3x3/8 angle:

Vertical load puts an equivalent uniform cantilever load on L3 = $3725/3''/6''$ (L3 length) = 207 lb/in/in (conservative since grating sits on C6 which sits on L3)

$$M_{\max} = \omega l^2/2 \text{ (AISC 1995, p. 2-302)} = (207)(3 - 11/16 \text{ (AISC 1995, p. 1-49)})^2/2 = 553.5 \text{ lb-in/in}$$

$$S = bd^2/6 \text{ (AISC 1995, p. 6-17)} = (1)(3/8)^2/6 = 0.02344 \text{ in}^3/\text{in}$$

$$f_b = M/S = 553.5/0.02344/1000 = 23.6 \text{ ksi} < F_b = 0.75F_y \text{ (AISC 1995, Equation F2-1)} = (.75)(36) = 27 \text{ ksi} \therefore \text{OK}$$

Design ASTM A307 bolt attachment for C6 to L3:

$$\text{Max fastener} = 5/8'' \text{ (AISC 1995, p. 1-40)}$$

Max. shear = horizontal seismic load = $(0.3)(440) = 132 \text{ lbs} < \text{allowable shear} = 3.1 \text{ kips}$ (AISC 1995, Table I-D) $\therefore$ OK

Design L3 weld to existing frame using E70XX electrodes:

A 3/8" end plate must first be welded continuously to the existing W6 using 3/16" welds. The L3 can then be welded to the 3/8" end plate along the bottom edge using a 1/4" weld.

Allowable shear on effective area = $0.30 \times \text{nominal tensile strength of weld metal}$ (AISC 1995 Table J2.5) = $(.3)(70) = 21 \text{ ksi}$

By inspection, effective area of L3 to end plate weld will control:

Effective area = $(0.707)(\text{weld thickness})(\text{weld length})$ (AISC 1995 Section J2.a) = $(.707)(.25)(6") = 1.06 \text{ in}^2$

Allowable shear = $(21)(1.06) = 22.26 \text{ kips}$

Actual shear = $3725/1000 = 3.725 \text{ kips} < 22.26 \text{ kips} \therefore$ OK

Design knee brace attachments:

Although the single L3x2x3/8 member is adequate as the knee brace, conservatively use two L3x2x3/8 angles together for the knee brace since the knee brace is the most critical member of the platform.

By inspection, L4x4x3/8 angles w/ 3/8" plates welded between the angle legs are adequate. Use 1/4" continuous welds.

Try 3/4" ϕ ASTM A307 bolt attachment for L3s to 3/8" plates:

Usual gage for L3 = $1\frac{3}{4}"$ (AISC 1995, p.1-52) which leaves an edge distance measured from center of standard hole = $3-1.75 = 1.25" > \text{minimum edge distance} = 1"$ (AISC 1995, Table J3.5) $\therefore$ OK

Max. shear = 6061 lbs (Attachment II, page II-8) $< \text{allowable shear} = 8.8 \text{ kips}$ (AISC 1995, Table I-D) $\therefore$ OK

Design L3 weld to existing W6 flange / new C6 frame using E70XX electrodes:

W6 $t_f = \frac{1}{4}"$ (AISC 1995, p. 1-32) $< \text{C6 } t_f = \frac{5}{16}"$ (ASTM 1995, p. 1-40) $\therefore$ use 3/16" welds

Using a minimum weld length of 6" on both the W6 and C6, the effective area = $(.707)(3/16)(6") = 0.795 \text{ in}^2$

Allowable shear = $(21)(0.795) = 16.7 \text{ kips}$

Actual shear = 6.061 kips $< 16.7 \text{ kips} \therefore$ OK

Check if variant frame at Station 20+00 m can support new platform:

Reviewing the generic design results, the highest interaction ratio on the existing members = 0.310 (Attachment II, page II-9). Taking into account the smaller span and lighter loads of the variant frame, and the low interaction results of the generic design, the smaller frame members are approved by inspection.

All welding shall be in accordance with AWS D1.1:2000 and shall be visually inspected for undercut, inclusions, porosity, cracks and fissures in accordance with Section 6.9 of AWS D1.1. NOTE: An impact review has been performed (CRWMS M&O 2000) and determined that work may continue under ANSI/AWS D1.1-98. Fiberglass grating, handrail and toe plate shall be fastened per manufacturer's recommendations. Handrail shall meet the loading requirements of UBC, Table 16-B (ICBO 1997). Ladders shall be fastened to both ends of

the platform. Signs meeting the requirements of ANSI Z535.2 shall be prepared stating "PLATFORM LIVE LOAD LIMIT 125 LBS. PER SQ. FT." and shall be posted at both ends of each new platform. Washers shall conform to ASTM F436 minimum. Nuts shall conform to ASTM A563 minimum.

7. CONCLUSIONS

- 7.1 The existing frames are adequate as-constructed to support the MPCs and to sustain a design seismic event. Each individual mine power center section shall be anchored to an existing frame structural member (C6 or L3) using a minimum of (4) ASTM A307 5/8" ϕ bolts. The column base plates for the existing frame at Station 20+00 m shall be anchored to the concrete floor.
- 7.2 MPC platforms shall consist of a C6x10.5 box frame with fiberglass grating, handrail and toe plate and have equally spaced L3x3x3/16 intermediate support braces. The box frame shall attach at the center and ends of the existing MPC frames. 3/8" end plates shall be continuously welded to the existing W6 beams at these locations using 3/16" welds. L3x3x3/8 angles shall be welded to these plates using 1/4" welds and then bolted to the C6 frame using 5/8" ϕ ASTM A307 bolts. L4x4x3/8 angles with 3/8" plates welded between the legs using 1/4" continuous welds shall be welded to the existing W6 columns and to the outer edge of the C6 frame using 3/16" welds. Two (2) L3x2x3/8 knee braces shall be bolted to the 3/8" plates using 3/4" ϕ ASTM A307 bolts. All steel shall conform to ASTM A36. All welding shall be in accordance with AWS D1.1:2000 and use E70XX electrodes. Fiberglass grating shall be equivalent to KORDEK RKD 1.0 compression molded fiberglass composite grating as manufactured by International Grating, Inc. Fiberglass grating, handrail and toe plate shall be fastened per manufacturer's recommendations. Handrail shall meet the loading requirements of UBC, Table 16-B (ICBO 1997). Ladders shall be fastened to both ends of the new platforms. The new platform support steel shall be electrically bonded to the existing frames. Signs meeting the requirements of ANSI Z535.2 shall be prepared stating "DANGER DE-ENERGIZE 12.47 kV POWER BEFORE SERVICING" and shall be posted on each individual MPC section. Signs meeting the requirements of ANSI Z535.2 shall be prepared stating "PLATFORM LIVE LOAD LIMIT 125 LBS. PER SQ. FT." and shall be posted at both ends of each new platform. Washers shall conform to ASTM F436 minimum. Nuts shall conform to ASTM A563 minimum.

8. INPUTS AND REFERENCES

8.1 DOCUMENTS CITED

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9. ATTACHMENTS

There are two attachments to this analysis.

ATTACHMENT	DESCRIPTION
I	Existing MPC Frame Information / New Platform Sketches
II	STAAD-III Input and Output Information

ATTACHMENT I

EXISTING MPC FRAME INFORMATION / NEW PLATFORM SKETCHES

A field inspection of the existing MPC frames was conducted on August 09, 1999 by T. Misiak, EBSO/TFD. The existing frame plan and sections are shown on the following (2) pages (NOTE: sketches are shown with proposed platform details).

The existing MPC frames consist of a C6x10.5 box frame with $\frac{3}{4}$ number 9 expanded metal grating and intermediate equally spaced L3x3x3/16 supports, attached to W6x15 beam/column supports. The beam and column are both welded to 14" x 10" x $\frac{1}{2}$ " base plates that are attached to the tunnel wall by (2) 900 mm SS-39 Split Set stabilizers (TYP). The location, number of bays, and bay widths of the existing frames are shown in the following table (NOTE: Station shown is at center of frame):

LOCATION	# BAYS	BAY WIDTH(S)	DIST *	NOTES
9+78 m	4	70" - 75"	21"	
17+72 m	4	68" - 74"	16"	
20+03 m	2	72"	21"	400 kVA mine power center. Columns are W6x9, approx. 4 ft high, and are attached to base plates that sit flat against concrete floor. Base plates are not anchored to the concrete.
28+01 m	4	82" - 84"	20"	
28+46 m	4	82" - 83"	30"	
34+81 m	4	81" - 84"	21"	
46+98 m	4	72"	21"	
50+41 m	4	72"	19"	400 kVA mine power center
57+51 m	4	72"	18"	
64+61 m	4	72"	13"	

* DIST = Horizontal distance measured from the edge of the frame to the raised corner of the concrete invert (approximately equal to the edge of the transportation corridor, see CRWMS M&O 1994).

The typical frame is approximately 75" from top of grating to the top of the invert. The typical 400 kVA mine power center weighs approximately 5000 lbs.

CLEARANCE:

The widest piece of equipment typically used on a daily basis is the "white ride" self-propelled personnel carrier: width of white ride = 74".

Distance from Φ of center track to edge of existing transportation corridor = $12\frac{1}{2} = 6'$ (CRWMS M&O 1994)

Dist from Φ of center track to edge of new platform (worst case right side) = $6' + 13" - 3'2" = 47"$

Maximum clearance (right side) = dist from Φ of center track to edge of new platform - $\frac{1}{2}$ white ride width = $47 - \frac{1}{2}(74) = 10" \therefore$ OK

Distance from Φ of center track to edge of Booster Drive #1 @ Station 9+88 m (worst case left side, field measured concurrently with MPCs) = 65"

Maximum clearance (left side) = $65 - \frac{1}{2}(74) = 28" \therefore$ OK

Revised horizontal transportation corridor = 47" right side, 65" left side, measured from Φ of tunnel.

PLAN

MINE POWER CENTER
 PLATFORMS
 PLAN

ATTACHMENT II

STAAD-III INPUT AND OUTPUT INFORMATION

STAAD-III INPUT FILE FOR EXISTING MPC FRAME

```
STAAD PLANE MINE POWER CENTER FRAME(1)
*
* ANALYZE EXISTING MINE POWER CENTER FRAME
* FILENAME = MPCFRM1.STD
*
UNIT FT POUND
JOINT COORD
1 0.0 0.0 ; 2 -3.167 0.0 ; 3 -4.0 0.0 ; 4 -3.167 -4.583
MEMB INCI
1 1 2 ; 2 2 3 ; 3 2 4
MEMB PROP
1 2 3 TABLE ST W6X15
CONSTANT
E STEEL ALL
DENSITY STEEL ALL
SUPPORT
1 4 PINNED
LOADING 1 DEAD LOADS OF FRAME, CHANNEL, EXP METAL, AND MPC
SELFWEIGHT
MEMBER LOAD
1 2 UNI GY -10.5
JOINT LOAD
1 3 FY -3600.0
LOAD COMBINATION 11 DEAD + SESIMIC=0.3(DEAD)/1.4=0.214(DEAD)
1 1.0 1 0.214
PERFORM ANALYSIS
PRINT SUPPORT REACTIONS
PARAMETER
CODE AISC
CHECK CODE
FINISH
```

STAAD-III OUTPUT FILE FOR EXISTING MPC FRAME

```

*****
*
*           S T A A D - I I I
*           Revision 22.3a
*           Proprietary Program of
*           Research Engineers, Inc.
*           Date=      NOV 10, 1999
*           Time=      8:40:28
*           Build No.   2434
*           USER ID: TRW
*****

```

```

1. STAAD PLANE MINE POWER CENTER FRAME(1)
2. *
3. * ANALYZE EXISTING MINE POWER CENTER FRAME
4. * FILENAME = MPCFRM1.STD
5. *
6. UNIT FT POUND
7. JOINT COORD
8. 1 0.0 0.0 ; 2 -3.167 0.0 ; 3 -4.0 0.0 ; 4 -3.167 -4.583
9. MEMB INCI
10. 1 1 2 ; 2 2 3 ; 3 2 4
11. MEMB PROP
12. 1 2 3 TABLE ST W6X15
13. CONSTANT
14. E STEEL ALL
15. DENSITY STEEL ALL
16. SUPPORT
17. 1 4 PINNED
18. LOADING 1 DEAD LOADS OF FRAME, CHANNEL, EXP METAL, AND MPC
19. SELFWEIGHT
20. MEMBER LOAD
21. 1 2 UNI GY -10.5
22. JOINT LOAD
23. 1 3 FY -3600.0
24. LOAD COMBINATION 11 DEAD + SESIMIC=0.3(DEAD)/1.4=0.214(DEAD)
25. 1 1.0 1 0.214
26. PERFORM ANALYSIS

```

P R O B L E M S T A T I S T I C S

```

-----
NUMBER OF JOINTS/MEMBER+ELEMENTS/SUPPORTS =      4/      3/      2
ORIGINAL/FINAL BAND-WIDTH =      2/      2
TOTAL PRIMARY LOAD CASES =      1, TOTAL DEGREES OF FREEDOM =      8
SIZE OF STIFFNESS MATRIX =      56 DOUBLE PREC. WORDS
REQRD/AVAIL. DISK SPACE = 12.00/ 1062.9 MB,  EXMEM = 1964.0 MB

```

```

++ Processing Element Stiffness Matrix.      8:40:28
++ Processing Global Stiffness Matrix.      8:40:29
++ Processing Triangular Factorization.      8:40:29
++ Calculating Joint Displacements.          8:40:29
++ Calculating Member Forces.               8:40:29

```


27. PRINT SUPPORT REACTIONS

SUPPORT REACTIONS -UNIT POUN FEET STRUCTURE TYPE = PLANE

JOINT	LOAD	FORCE-X	FORCE-Y	FORCE-Z	MOM-X	MOM-Y	MOM Z
1	1	293.79	3115.91	.00	.00	.00	.00
	11	356.66	3782.72	.00	.00	.00	.00
4	1	-293.79	4255.21	.00	.00	.00	.00
	11	-356.66	5165.83	.00	.00	.00	.00

***** END OF LATEST ANALYSIS RESULT *****

28. PARAMETER

29. CODE AISC

30. CHECK CODE

STAAD-III CODE CHECKING - (AISC)

ALL UNITS ARE - POUN FEET (UNLESS OTHERWISE NOTED)

MEMBER	TABLE	RESULT/ FX	CRITICAL COND/ MY	RATIO/ MZ	LOADING/ LOCATION
1	ST W6X 15	PASS	AISC- H2-1	.119	11
		356.66 T	.00	2016.71	3.17
2	ST W6X 15	PASS	SHEAR -Y	.222	11
		.00 C	.00	3651.30	.00
3	ST W6X 15	PASS	AISC- H1-3	.153	11
		5082.13 C	.00	1634.59	.00

31. FINISH

***** END OF STAAD-III *****

**** DATE= NOV 10,1999 TIME= 8:40:29 ****

* For questions on STAAD-III, contact: *

* Research Engineers, Inc at Build No. 2434 *

* West Coast: Ph- (714) 974-2500 Fax- (714) 921-2543 *

* East Coast: Ph- (978) 688-3626 Fax- (978) 685-7230 *

STAAD-III INPUT FILE FOR EXISTING MPC FRAME & NEW PLATFORM

```
STAAD PLANE MINE POWER CENTER FRAME(2)
*
* ANALYZE EXISTING MINE POWER CENTER FRAME WITH NEW PLATFORM
* FILENAME = MPCFRM2.STD
*
UNIT FT POUND
JOINT COORD
1 0.0 0.0 ; 2 -3.167 0.0 ; 3 -4.0 0.0 ; 4 -7.0 0.0
5 -3.167 -3.833 ; 6 -3.167 -4.583
MEMB INCI
1 1 2 ; 2 2 3 ; 3 3 4 ; 4 4 5 ; 5 2 5 ; 6 5 6
MEMB PROP
1 2 5 6 TABLE ST W6X15
3 TABLE ST C6X10
4 TABLE ST L30206
CONSTANT
E STEEL ALL
DENSITY STEEL ALL
SUPPORT
1 6 PINNED
LOADING 1 DEAD LOADS OF EXISTING FRAME, MPC, AND NEW PLATFORM
SELFWEIGHT
JOINT LOAD
1 FY -2925.0
3 FY -3365.0
4 FY -440.0
LOADING 2 LIVE LOAD ON PLATFORM
JOINT LOAD
3 4 FY -3285.0
LOAD COMBINATION 11 DEAD + LIVE
1 1.0 2 1.0
LOAD COMBINATION 12 DEAD + SESIMIC=0.3(DEAD)/1.4=0.214(DEAD)
1 1.0 1 0.214
LOAD COMBINATION 13 DEAD + 0.75(LIVE) + 0.75(SEISMIC)=0.161(DEAD)
1 1.0 2 0.75 1 0.161
PERFORM ANALYSIS
PRINT SUPPORT REACTIONS
PRINT MEMBER FORCES ALL
PARAMETER
CODE AISC
CHECK CODE
FINISH
```

STAAD-III OUTPUT FILE FOR EXISTING MPC FRAME & NEW PLATFORM

```

*****
*
*          S T A A D - I I I
*          Revision 22.3a
*          Proprietary Program of
*          Research Engineers, Inc.
*          Date=      NOV 10, 1999
*          Time=      10: 1:48
*          Build No.   2434
*          USER ID: TRW
*****

```

```

1. STAAD PLANE MINE POWER CENTER FRAME (2)
2. *
3. * ANALYZE EXISTING MINE POWER CENTER FRAME WITH NEW PLATFORM
4. * FILENAME = MPCFRM2.STD
5. *
6. UNIT FT POUND
7. JOINT COORD
8. 1 0.0 0.0 ; 2 -3.167 0.0 ; 3 -4.0 0.0 ; 4 -7.0 0.0
9. 5 -3.167 -3.833 ; 6 -3.167 -4.583
10. MEMB INCI
11. 1 1 2 ; 2 2 3 ; 3 3 4 ; 4 4 5 ; 5 2 5 ; 6 5 6
12. MEMB PROP
13. 1 2 5 6 TABLE ST W6X15
14. 3 TABLE ST C6X10
15. 4 TABLE ST L30206
16. CONSTANT
17. E STEEL ALL
18. DENSITY STEEL ALL
19. SUPPORT
20. 1 6 PINNED
21. LOADING 1 DEAD LOADS OF EXISTING FRAME, MPC, AND NEW PLATFORM
22. SELFWEIGHT
23. JOINT LOAD
24. 1 FY -2925.0
25. 3 FY -3365.0
26. 4 FY -440.0
27. LOADING 2 LIVE LOAD ON PLATFORM
28. JOINT LOAD
29. 3 4 FY -3285.0
30. LOAD COMBINATION 11 DEAD + LIVE
31. 1 1.0 2 1.0
32. LOAD COMBINATION 12 DEAD + SESIMIC=0.3(DEAD)/1.4=0.214(DEAD)
33. 1 1.0 1 0.214
34. LOAD COMBINATION 13 DEAD + 0.75(LIVE) + 0.75(SEISMIC)=0.161(DEAD)
35. 1 1.0 2 0.75 1 0.161
36. PERFORM ANALYSIS

```

P R O B L E M S T A T I S T I C S

NUMBER OF JOINTS/MEMBER+ELEMENTS/SUPPORTS = 6/ 6/ 2
 ORIGINAL/FINAL BAND-WIDTH = 3/ 2
 TOTAL PRIMARY LOAD CASES = 2, TOTAL DEGREES OF FREEDOM = 14
 SIZE OF STIFFNESS MATRIX = 126 DOUBLE PREC. WORDS
 REQD/AVAIL. DISK SPACE = 12.01/ 1063.5 MB, EXMEM = 1963.9 MB

++ Processing Element Stiffness Matrix. 10: 1:48
 ++ Processing Global Stiffness Matrix. 10: 1:48
 ++ Processing Triangular Factorization. 10: 1:48
 ++ Calculating Joint Displacements. 10: 1:48
 ++ Calculating Member Forces. 10: 1:48

37. PRINT SUPPORT REACTIONS

SUPPORT REACTIONS -UNIT POUN FEET STRUCTURE TYPE = PLANE

JOINT	LOAD	FORCE-X	FORCE-Y	FORCE-Z	MOM-X	MOM-Y	MOM Z
1	1	786.55	2625.29	.00	.00	.00	.00
	2	2962.43	-552.88	.00	.00	.00	.00
	11	3748.99	2072.41	.00	.00	.00	.00
	12	954.88	3187.10	.00	.00	.00	.00
6	13	3135.01	2633.30	.00	.00	.00	.00
	1	-786.55	4297.24	.00	.00	.00	.00
	2	-2962.43	7122.88	.00	.00	.00	.00
	11	-3748.99	11420.12	.00	.00	.00	.00
	12	-954.88	5216.85	.00	.00	.00	.00
	13	-3135.01	10331.25	.00	.00	.00	.00

***** END OF LATEST ANALYSIS RESULT *****

38. PRINT MEMBER FORCES ALL

MEMBER END FORCES STRUCTURE TYPE = PLANE

ALL UNITS ARE -- POUN FEET

MEMBER	LOAD	JT	AXIAL	SHEAR-Y	SHEAR-Z	TORSION	MOM-Y	MOM-Z
1	1	1	-786.55	-299.71	.00	.00	.00	.00
		2	786.55	347.36	.00	.00	.00	-1024.63
2	1	1	-2962.43	-552.88	.00	.00	.00	.00
		2	2962.43	552.88	.00	.00	.00	-1750.98
11	1	1	-3748.99	-852.59	.00	.00	.00	.00
		2	3748.99	900.24	.00	.00	.00	-2775.61
12	1	1	-954.88	-363.85	.00	.00	.00	.00
		2	954.88	421.69	.00	.00	.00	-1243.90
13	1	1	-3135.01	-762.63	.00	.00	.00	.00
		2	3135.01	817.94	.00	.00	.00	-2502.83

MEMBER	LOAD	JT	AXIAL	SHEAR-Y	SHEAR-Z	TORSION	MOM-Y	MOM-Z
2	1	2	-777.41	3078.82	.00	.00	.00	1623.05
		3	777.41	-3066.29	.00	.00	.00	936.38
	2	2	-3489.07	3066.95	.00	.00	.00	1920.71
		3	3489.07	-3066.95	.00	.00	.00	634.05
	11	2	-4266.48	6145.77	.00	.00	.00	3543.77
		3	4266.48	-6133.24	.00	.00	.00	1570.44
	12	2	-943.78	3737.69	.00	.00	.00	1970.39
		3	943.78	-3722.48	.00	.00	.00	1136.77
	13	2	-3519.38	5874.72	.00	.00	.00	3324.90
		3	3519.38	-5860.18	.00	.00	.00	1562.68
3	1	3	-777.41	-298.71	.00	.00	.00	-936.38
		4	777.41	330.19	.00	.00	.00	-6.97
	2	3	-3489.07	-218.05	.00	.00	.00	-634.05
		4	3489.07	218.05	.00	.00	.00	-20.10
	11	3	-4266.48	-516.76	.00	.00	.00	-1570.44
		4	4266.48	548.24	.00	.00	.00	-27.07
	12	3	-943.78	-362.63	.00	.00	.00	-1136.77
		4	943.78	400.85	.00	.00	.00	-8.46
	13	3	-3519.38	-510.34	.00	.00	.00	-1562.68
		4	3519.38	546.89	.00	.00	.00	-23.16
4	1	4	1094.32	5.11	.00	.00	.00	-6.97
		5	-1116.89	17.47	.00	.00	.00	-26.54
	2	4	4944.18	-9.89	.00	.00	.00	-20.10
		5	-4944.18	9.89	.00	.00	.00	-33.48
	11	4	6038.50	-4.78	.00	.00	.00	-27.07
		5	-6061.07	27.35	.00	.00	.00	-60.02
	12	4	1328.50	6.20	.00	.00	.00	-8.46
		5	-1355.91	21.20	.00	.00	.00	-32.22
	13	4	4978.64	-1.49	.00	.00	.00	-23.16
		5	-5004.84	27.69	.00	.00	.00	-55.92
5	1	2	3426.18	9.14	.00	.00	.00	598.42
		5	-3483.84	-9.14	.00	.00	.00	-563.38
	2	2	3619.83	-526.64	.00	.00	.00	169.74
		5	-3619.83	526.64	.00	.00	.00	-2188.34
	11	2	7046.01	-517.50	.00	.00	.00	768.16
		5	-7103.67	517.50	.00	.00	.00	-2751.72
	12	2	4159.38	11.10	.00	.00	.00	726.49
		5	-4229.39	-11.10	.00	.00	.00	-683.94
	13	2	6692.67	-384.36	.00	.00	.00	822.07
		5	-6759.62	384.36	.00	.00	.00	-2295.34
6	1	5	4285.95	786.55	.00	.00	.00	589.92
		6	-4297.24	-786.55	.00	.00	.00	.00
	2	5	7122.88	2962.43	.00	.00	.00	2221.83
		6	-7122.88	-2962.43	.00	.00	.00	.00
	11	5	11408.84	3748.99	.00	.00	.00	2811.74
		6	-11420.12	-3748.99	.00	.00	.00	.00
	12	5	5203.15	954.88	.00	.00	.00	716.16
		6	-5216.85	-954.88	.00	.00	.00	.00
	13	5	10318.15	3135.01	.00	.00	.00	2351.26
		6	-10331.25	-3135.01	.00	.00	.00	.00

***** END OF LATEST ANALYSIS RESULT *****

39. PARAMETER

40. CODE AISC
41. CHECK CODE

STAAD-III CODE CHECKING - (AISC)

ALL UNITS ARE - POUN FEET (UNLESS OTHERWISE NOTED)

MEMBER	TABLE	RESULT/ FX	CRITICAL COND/ MY	RATIO/ MZ	LOADING/ LOCATION
1	ST W6X 15	PASS	AISC- H2-1	.198	11
		3748.99 T	.00	2775.61	3.17
2	ST W6X 15	PASS	SHEAR -Y	.310	11
		4266.48 T	.00	3543.77	.00
3	ST C6X 10	PASS	AISC- H2-1	.236	11
		4266.48 T	.00	-1570.44	.00
4	ST L30 206	PASS	AISC- H1-1	.702	11
		6061.07 C	.00	60.02	5.42
5	ST W6X 15	PASS	AISC- H1-3	.238	11
		7103.67 C	.00	2751.72	3.83
6	ST W6X 15	PASS	AISC- H1-3	.281	11
		11408.84 C	.00	2811.74	.00

42. FINISH

***** END OF STAAD-III *****

**** DATE= NOV 10,1999 TIME= 10: 1:48 ****

* For questions on STAAD-III, contact: *
* Research Engineers, Inc at Build No. 2434 *
* West Coast: Ph- (714) 974-2500 Fax- (714) 921-2543 *
* East Coast: Ph- (978) 688-3626 Fax- (978) 685-7230 *