REQUEST FOR INTEREST No. ADPM-004
REQUEST FOR INTEREST CRITERIA
Third Party Commercial Grade Dedication Services, Furnish and Deliver Safety Systems Specifically for TA-63 TWF Phase B Project

Procurement Specialist: Karin Antal

Due Date: February 22, 2013

Los Alamos National Security, LLC (LANS) intends to issue a Request for Proposal (RFP) for performance of Commercial Grade Dedication Support for Safety Systems associated with the Transuranic Waste Storage Facility at the Los Alamos National Laboratory (LANL). In preparation for this RFP, LANL is issuing a Request for Interest (RFI) to obtain budgetary estimates and statements of prequalification from interested firms.

A secondary intent of this RFI is to establish the suitability and practicality of using a third party dedicator for some or all of the safety systems associated with this project. This RFI contemplates the potential provision of two such safety systems as identified in the Scope of Work on page 4. Other Safety Systems which may be included in future RFPs include an electric / diesel fire pump skid; a 150 K gallon (approx) fire water tank; and the instrumentation and controls associated with facility safety systems, primarily associated with fire suppression.

Responses to the RFI are not binding on either party. The RFI is being issued for informational purposes only and does not obligate LANS to consider the information for a future RFP or award of a subcontract, if any. Based on the responses to the RFI outlining the respondents' capabilities, LANS will develop a bidders list for potential release of an RFP for the services described herein.

To be deemed responsive, respondent must provide documentation that clearly demonstrates its ability to meet each element of the Criteria set forth below and provide a system specific budgetary estimate based on the Deliverables of this RFI. All information submitted must be organized in a manner that will allow reviewers to easily locate responses to questions and requirements. Information submitted must directly address the Prequalification Criteria below or it may not be considered. Failure to clearly state how the Prequalification Criteria are met, or failure to respond by the due date, may result in a respondent not receiving the RFP.

To support the prequalification evaluation process, provide the following information:

Potential Respondent Name:	
Business Size Classification:	
Address:	
Contact Name:	
Phone Number:	
Fax Number:	
Email Address:	
DUNS No.:	

Potential Respondent/Teaming Partners/Lower-Tier Subcontractors:

While all aspects of subcontract performance may be accomplished by a single company, a potential respondent may elect to use teaming partner(s), including lower-tier subcontractor(s). A determination of respondents capabilities will be based upon the experience and capabilities of <u>all</u> the potential respondent's teaming partner(s), including lower-tier subcontractor(s). Vendors providing fabricated safety system components are not required to be identified as a teaming partner or lower tier subcontractor.

A detailed description must be provided of how the potential respondent's team will be comprised, including each company, teaming partner, and lower-tier subcontractor and demonstrate that the team will meet all of the specified Prequalification Criteria below. In addition, provide a brief discussion of the technical approach the team will take to perform the scope of work provided. The description of the scope of work should include a presentation of the team's conceptual approach to project execution by members of the team. In addressing each of the Prequalification Criteria, the potential respondent must clearly identify which teaming partner's experience is being cited, consistent with the potential respondent's planned structure, and demonstrate how the team will operate as a business entity.

Evaluation of the experience of the respondent shall be limited to that of the respondent's lower-tier subcontractors, and other teaming partners. The experience of parent companies, subsidiaries, or other corporate affiliates will not be considered unless those corporate entities are also a part of the respondent's team and meet all applicable requirements of these Prequalification Criteria.

If the supporting information provided at the time a proposal is made does not support a "Yes" answer to any of the Prequalification Criteria questions below, the potential respondent's proposal may be deemed unacceptable and excluded from further consideration.

The content of this request may be duplicated as necessary in order to submit responsive data for all teaming partner(s) and teaming subcontractor(s). Note that the content of this request must also be used by a successful subcontractor to submit data if it proposes to substitute a lower-tier subcontractor after award.

Data submitted for (Company Name):

This company is proposed as (check one):

☐ Prime Subcontractor
☐ Lower-tier Subcontractor
☐ Teaming Partner

Is this company Large or Small under NAICS Code 541330 Engineering Services at $4.5 Million.

☐ Large
☐ Small

What dollar amount is this company's Bonding Capacity?

Value:____________________

Do the Respondent and/or Lower-tier Subcontractors have demonstrated experience with installation of Nuclear safety systems? This criterion is an inquiry and will not be included as qualification requirements.

☐ **Yes** ☐ **No** ☐ **By Respondent's Firm**
☐ **Yes** ☐ **No** ☐ **By Lower-tier Subcontractors**

The determination of whether a potential respondent is or is not prequalified will be based upon the capabilities of the company, team or other legal entity that is described in the prequalification submission.

Scope of Work:

LANS is seeking to identify potential qualified suppliers for third party Commercial Grade Dedication services and provision of Safety Systems in accordance with NQA-1 a-2009, Subpart 2.14. The scope as described herein includes development and execution of Commercial Grade Dedication (CGD) activities associated with two safety class systems at the Los Alamos National Laboratory. This scope includes all activities from development of the CGD plan through post installation testing, including purchase, storage and delivery of the safety system components. The installation of these systems will be performed by others. Surveillance and documentation of the installation activities for successful CGD of these systems are included in the scope of the third party dedicator. Further, the SUBCONTRACTOR shall plan, schedule, coordinate, test, inspect and assure effective performance of all aspects of Commercial Grade Dedication.

LANL Inputs to Potential Offerors:

The following documents will be provided in any resulting RFP.

1. Approved Safety Basis documentation (Preliminary Documented Safety Analysis) PDSA
2. Approved applicable project design documentation, drawings, specifications, cut sheets, etc.
3. A component level listing of Critical Characteristics (CCs) for safety related components
4. Designation of those systems, structures and components which will be subject to CGD.
5. Technical Evaluations including Failure Modes and Effects Analysis (system / component specific)

Project Mission and Scope of Work at TA-63 TWF Phase B:

The TWF Project is located in the TA-63 site south of the Puye Road and west of Pajarito Road. It is designed, permitted, will be constructed, and commissioned as a Hazard Category (HC)-2 nuclear facility with a Resource Conservation and Recovery Act (RCRA) permit to store hazardous wastes.

SUBCONTRACTOR is expected to contribute to the foregoing goals and objectives in the following manner: SUBCONTRACTOR shall perform the Work safely, in accordance with CONTRACTOR's Environmental, Health and Safety Program, procure materials, test and inspect fabricated materials to assure compliance with approved commercial grade dedication plans in accordance with requirements in DOE Order 414.1D, Quality Assurance, as a minimum, and implementing ASME NQA-1-2008/2009a for ML-1, ML-2 structures systems and components (SSCs) and activities in an effort to complete the work with zero accidents and quality performance.

The CGD and procurement scope is comprised of the Deliverables described below for these Safety Class systems:

- Seismic Power Cutoff System (Safety Class)
- K12 Vehicle barriers to protect the storage buildings (Safety Class)

Desired Capabilities (not required at RFI stage)

The successful respondent will be responsible for the following scope:

1. Commercial Grade Dedication Plans for the Seismic Switch and Vehicle Barriers as described in the following Failure Modes and Effects Analysis and design documentation included in Attachment 4 and 5:
    - *Failure Modes and Effects Analysis of Seismic Power Cutoff System for the TA-63 TRU Waste Facility Project Phase B Design,* 11-001-FMEA-001 Rev 0
    - *Failure Modes and Effects Analysis of Vehicle Barriers for the TA-63 TRU Waste Facility Project Phase B Design,* 11-001-FMEA-002 Rev 0

2. Preparation of procurement documentation including Requests for Quotation, Engineered Equipment Procurement Specifications.
3. Sampling Plan for hardware, as applicable, including sample sizes and testing and acceptance criteria, and justification for sampling strategy.
4. Recommendations for acceptance methods, e.g., CGD Methods 1-4 as delineated in NQA-1 2008/2009 addenda Part II Subpart 2.14.
5. Performance of Commercial Grade Surveys and source inspections including all documentation. Modifications to CGD Plans resulting from Commercial Grade Surveys or source verifications are included in this scope.
6. Testing and Inspection Plans including the performance of any tests or inspections conducted as the dedicating entity.
7. Performance of all CGD acceptance activities performed by fabricators, testing agencies and constructors. With RFI
8. Preparation for and performance of receipt inspection at the job site.
9. Verification of Inspector qualifications or other qualifications required for the fabrication and acceptance of Critical Characteristics.
10. Identification of Special Processes and acceptance methods including training, etc.
11. In process acceptance of Critical Characteristics including those performed in other locations, e.g., Factory Acceptance Testing, Commercial Grade Surveys, Source Verifications, etc.
12. Storage of safety system components, post fabrication, until delivery to LANL in accordance with ASME NQA-1, 2008/2009 addenda requirements.
13. Formal submittal of all related procurement (including CGD Plans, Inspection Plans, Commercial Grade Survey Plans, and Source Verification Plans), training, qualification, calibration, testing, inspection, acceptance and other documentation.
14. Costs associated with special tests and inspections and post installation testing are included.
15. Fabrication of components and reasonable storage costs that prevents environmental degradation; assume up to 12 months of controlled storage.

Non-Binding Budgetary estimates shall be submitted with this expression of interest pre-qualification package that reflect the above deliverable scope for the K-12 Vehicle Barrier and Seismic Power Cutoff System safety systems Responders are to use Attachment 3 for this portion of the pre-qualification package. LANL makes no representation of intent to make an award on such numbers.

Excluded Scope

Installation of these systems will be completed by a commercial constructor operating under a commercial (not NQA-1) Quality Assurance Plan. Specific requirements will need to be identified to add to the construction contract based on LANL approved commercial grade dedication plans prepared by the third party dedicator.

LANL will be the dedicating entity for concrete related work for the Seismic Power Cutoff System. Reinforcements and anchorages will remain the responsibility of the third party dedicator.

Environmental Safety and health Plan:

Contractor will provide a Environmental, Safety and Health Plan that addresses and enforces all requirements set forth in the Occupational Safety and Health Act (OSHA) standards, complying with 10CFR 851, Hazardous Waste Operations under 29 CFR 1910.120.

Quality Assurance Criteria:

The TRU Waste Facility is classified as a nuclear facility designated as Hazard Category 2, in accordance with DOE Standard 1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance* with *DOE Order 5480.23, Nuclear Safety Analysis Reports*. Given this designation Quality Assurance Quality Requirements have been developed in accordance with the Code of Federal Regulations and DOE Orders.

Title 10 "Energy" of the Code of Federal Regulations (CFR) Part 830, Subpart A Quality Assurance Requirements applies to all aspects of this Project. A graded approach may be applied in accordance with 10 CFR 830.7, *Graded Approach*.

This project must also comply with ASME NQA-1 2008 *Quality Assurance Requirements for Nuclear Facility Operations*, and the Addenda to ASME NQA-1 2008 (ASME NQA-1a-2009).

This project will require all 18 Requirements of Part I as applied in a graded manner. As a minimum Part II Subpart 2.7, *Quality Assurance Requirements for Computer Software for Nuclear Facility Applications* and Part II Subpart 2.14, *Quality Assurance Requirements for Commercial Grade Items and Services,* will be required. All other requirements of Part II must be considered for inclusion based on applicability to project scope. Non-mandatory Appendices Part III and Part IV are not required but may be considered for inclusion at the discretion of the Supplier.

This project must also comply with DOE Order 414.1D, Quality Assurance, Attachment I, *Contractor Requirements Document DOE O 414.1D, Quality Assurance;* Attachment II, *Quality Assurance Criteria;* Attachment III, *Suspect Counterfeit Items Prevention;* and Attachment IV, *Safety Software Quality Assurance Requirements*.

Suppliers must demonstrate a Quality Assurance Program that is compliant with the above requirements or a program that can become compliant with the above requirements. Consideration will be given to commercial nuclear quality programs compliant with 10 CFR Appendix B to Part 50, *Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants* or similar programs.

Location of the Work:

Project Location - TA-63 TWF Phase B Project, Los Alamos National Laboratory, Los Alamos, New Mexico

Subcontract Type:

Firm Fixed Price Subcontract

Targeted Period of Performance:

- Award: DOE FY13
- Two Years

Socio-Economic Set-Aside:

N/A

NAICS Code:

541330 Engineering Services at $4.5 Million

EVALUATION CRITERIA:

Answer the following questions in the affirmative only if the potential respondent can demonstrate successful performance within the past five years. The potential respondent, its teaming partners, including lower-tier subcontractors, as appropriate, must be able to answer "yes" and provide adequate support for each of criterion listed below to be considered responsive. If the potential respondent and its teaming partners base any of their qualifications on "equivalent" non-DOE experience, supporting documentation shall clearly crosswalk that experience to the specific DOE guidance or requirements contained in the documents cited in the criterion below.

LANS may elect not to consider a respondent that has relied too heavily on subcontractors to satisfy all evaluation criteria.

1. Does the Respondent have an Environment, Safety & Health Plan that complies with 10 CFR 851 Worker Safety & Health Program?

   ☐ **Yes** ☐ **No**

2. Do the Respondent and Lower-tier Subcontractors have an Experience Modification Rate of 1.0 or less; Total Recordable Injury/Illness Case Rate of 3.2 or less; and DART Case Rate of 1.4 or less? Refer to Appendix 1.

   ☐ **Yes** ☐ **No** ☐ **By Respondent's Firm**
   ☐ **Yes** ☐ **No** ☐ **By Lower-tier Subcontractors**

3. Do the Respondent and Lower-tier Subcontractors have demonstrated construction industry experience for a minimum of 5 years for the Respondent and 3 years for the lower-tier subcontractors?

   ☐ **Yes** ☐ **No** ☐ **By Respondent's Firm**
   ☐ **Yes** ☐ **No** ☐ **By Lower-tier Subcontractors**

4. Has this candidate performed safety system related work at a DOE or NRC Nuclear facility?

   ☐ **Yes** ☐ **No** ☐ **By Respondent's Firm**
   ☐ **Yes** ☐ **No** ☐ **By Lower-tier Subcontractors**

5. Has this candidate developed a Quality Assurance Program compliant with ASME NQA-1 2008/2009 or previous version, e.g., NQA-1 2000?

   ☐ **Yes** ☐ **No** ☐ **By Respondent's Firm**
   ☐ **Yes** ☐ **No** ☐ **By Lower-tier Subcontractors**

6. Has this candidate performed work in an NRC Licensed facility compliant with 10 CFR part 50 Appendix B?

   ☐ **Yes** ☐ **No** ☐ **By Respondent's Firm**
   ☐ **Yes** ☐ **No** ☐ **By Lower-tier Subcontractors**

7. Does this candidate have a Quality Assurance program compliant with 10 CFR 830 Subpart A?

   ☐ **Yes** ☐ **No** ☐ **By Respondent's Firm**
   ☐ **Yes** ☐ **No** ☐ **By Lower-tier Subcontractors**

8. Does this candidate have a Quality Assurance program compliant with DOE Order 414.1D (or earlier version, 414.1C)?

   ☐ **Yes** ☐ **No** ☐ **By Respondent's Firm**
   ☐ **Yes** ☐ **No** ☐ **By Lower-tier Subcontractors**

9. Does this candidate have a Suspect Counterfeit Items program?

   ☐ **Yes** ☐ **No** ☐ **By Respondent's Firm**
   ☐ **Yes** ☐ **No** ☐ **By Lower-tier Subcontractors**

10. Has the Candidate successfully demonstrated a commercial grade dedication of items or services in accordance with any of the following requirements [please note which process(es) were used]:

    1) ASME NQA-1 2008/2009 Part I, Introduction Section 400, Definitions.
    2) ASME NQA-1 2008/2009 Part I, Requirement 3, Design, Control.
    3) ASME NQA-1 2008/2009 Part I, Requirement 7, Control of Purchased Items and Services.
    4) ASME NQA-1 2008/2009 Part II, Subpart 2.14, QA Requirement for Commercial Grade Items and Services.
    5) EPRI NP-5652 Guideline for the Utilization of Commercial Grade Items in Nuclear Safety Related Applications
    6) Other, please describe

    ☐ **Yes** ☐ **No** ☐ **By Respondent's Firm**
    ☐ **Yes** ☐ **No** ☐ **By Lower-tier Subcontractors**

11. How many years have the Respondent and Lower-tier Subcontractors worked in accordance with ASME NQA-1 projects that meet ASME NQA-1 2008 Quality Assurance Requirements for Nuclear Facility Operations, and the Addenda to ASME NQA-1 2008 (ASME NQA-1a-2009). List when and where. (Use a separate page to describe the NQA-1 projects including scope).

    ☐ **Yes** ☐ **No** ☐ **By Respondent's Firm**
    ☐ **Yes** ☐ **No** ☐ **By Lower-tier Subcontractors**

12. Has the candidate successfully performed CGD for items and/or services for a safety related system or component in a regulated or licensed nuclear site. Provide two examples of CGD item and two examples of CGD service dedication including scope description and Total Project Cost of CGD activities.

    ☐ **Yes** ☐ **No** ☐ **By Respondent's Firm**
    ☐ **Yes** ☐ **No** ☐ **By Lower-tier Subcontractors**

13. Has your firm successfully demonstrated a Software Quality Management process in accordance with any of the following requirements [please note which process(es) were used]: DOE Order 414.1D Attachment 4, Safety Software Quality Assurance Requirements ASME NQA-1 2008/2009 Part II, Subpart 2.7, Quality Assurance Requirements for Computer Software for Nuclear Facility Applications.

    Please list all that apply and number of software programs implemented including a brief description of scope.

    ☐ **Yes** ☐ **No** ☐ **By Respondent's Firm**

14. A non binding budgetary estimate for all deliverables listed. This non-binding budgetary estimate must be discrete for each system but may be an aggregate number for a system. Specific estimates by deliverable are not required. Responders may respond to one or both of the systems based on company experience and competencies. Future procurements may be system specific.

Documentation of Direct Relevant Experience:

Provide a reference list of example contracts/projects that demonstrate the directly relevant contract/project experience to support each of the foregoing RFI Criteria. Example contracts/projects should be detailed as to both the technical scope of the contract/project and the potential respondent's participation therein. In the case of a teaming arrangement, or where lower-tier subcontractors would play a significant role in the performance of this RFI, a separate list must be submitted for each entity, as applicable, to document such experience. Each reference will include an explanation of relevance and a crosswalk to the specific RFI Criteria being addressed by that contract/project.

Include the following information on each contract/project, as a minimum:

- Entity seeking Prequalification:
- Expected Role in this project:
- Client Name, Address, Contact and Telephone Number:
- Work Description:
- Value:
- Location:
- Commencement/Completion Dates:

Note: All information submitted in response to this RFI must be submitted by the potential respondent in the following manner:

The potential respondent's RFI submittal is to be submitted (both electronically and on one CD-ROM) to the Procurement Representative not later than 3:00 p.m. Mountain Time, February 22, 2013. The CD-ROMs shall be in searchable electronic format. The CD-ROM may be sent via U.S. Postal Service or other delivery service (e.g., Fed-Ex, UPS, DHL, etc.), but must be received by the due date to be considered.

Submittals sent via U.S. Postal Service should be addressed as follows:

Los Alamos National Security LLC
P.O. Box 1663, Mail Stop M873
Los Alamos, New Mexico 87545
Attention: Karin Antal
RFI No. ADPM-004

Submittals sent via other delivery services or those to be hand carried should be addressed as follows:

Los Alamos National Security LLC
Pajarito Complex, 3400 Arizona Avenue, Suite 141
Los Alamos, New Mexico 87544
Attention: Karin Antal
RFI No. ADPM-004

Questions may be addressed to the responsible Procurement Representative at:

E-mail: kantal@lanl.gov
Telephone: (505) 606-2317

ATTACHMENTS:

Attachment No. 1 – Safety Performance Eligibility worksheet
Attachment No. 2 – Environment, Safety and Health worksheet
Attachment No. 3 – Estimate worksheet
Attachment No. 4 – Failure modes and effects for Seismic Power Cutoff System
Attachment No. 5 – Failure modes and effects Vehicle Barriers

Attachment 1

SAFETY PERFORMANCE ELIGIBILITY REQUIREMENTS

LANS policy requires that all work performed at LANL must be conducted in a manner that protects workers, the public, and the environment. The objective of this policy is to establish a consistent, site-wide approach to worker protection by incorporating safety and health into daily activities. To support the effective implementation of this policy, firms should have a demonstrated safety performance equal to or lower than the following standards:

Statistical Standards		
Experience Modification Rate	The "EMR" is a number that is assigned to your company based on the insurance premium you pay and your loss statistics. Contact your insurance company for these numbers.	Maximum Allowable Average: **1.00**
Total Recordable Injury/Illness Case Rate (from Company OSHA 300 log)	Rate = <u>Total Recordable Injuries/Illnesses x 200,000</u> Total Employee Hours Worked	Maximum Allowable Average: **3.2**
DART Case Rate (Days Away From Work, Restriction, or Job Transfer) (from Company OSHA 300 log)	Rate = <u>Total Days Away/Restricted/Transferred Work Day Cases x 200,000</u> Total Employee Hours Worked	Maximum Allowable Average: **1.4**

Firms must submit a properly executed Environment, Safety, and Health Worksheet (Attachment 2) along with a letter from their Worker's Compensation Insurance Carrier certifying their Experience Modification Rate (EMR) performance. If any of the maximum allowable averages shown above is exceeded, the firm must provide information that clearly explains the excessive rate and demonstrates that the anomaly causing that excess was not easily preventable using sound safety practices.

If a firm is a joint venture, association, consortia, or partnership that has fewer than three years of demonstrated safety and/or environmental performance, each entity comprising the joint venture, association, consortia, or partnership must submit a properly executed Environment, Safety, and Health Worksheet (Attachment 2), along with a letter from their Worker's Compensation Insurance Carrier certifying its Experience Modification Rate (EMR) performance.

Any response received from a firm which does not provide the ES&H Worksheet(s), which exceeds any of the stated maximum allowable averages without an acceptable rationale, or which has fewer than three years of demonstrated safety and/or environmental performance, may, at LANS' sole discretion, be considered unacceptable.

If a firm intends to use lower-tier subcontractors to perform elements of the Scope of Work, those lower-tier subcontractors must also meet the maximum allowable averages specified above. The firm to whom a subcontract is awarded (i.e., Subcontractor) shall be responsible for ensuring that all of its lower-tier subcontractors meet the maximum allowable average safety performance eligibility requirements. When requested, the Subcontractor must demonstrate to LANS' satisfaction that its lower-tier subcontractors meet the maximum allowable average safety performance eligibility requirements. If any prospective lower-tier subcontractor does not meet one or more of the maximum allowable average safety performance eligibility requirements, the use of that lower-tier subcontractor must be evaluated and approved by both the Subcontractor and LANS before it can perform any work.

Attachment 2

ENVIRONMENT, SAFETY AND HEALTH WORKSHEET

Subcontractor Name:

Worksheet completed by:

Date:

LANS Proposed Subcontract/Prequalification Number: ADPM-001

1.	**Experience Modification Rate (EMR)**		
	List your firm's Interstate EMR for the past three (3) years and total hours worked.		
	Year:	EMR:	Hours Worked:
	Year:	EMR:	Hours Worked:
	Year:	EMR:	Hours Worked:
		3-year average:	
	If the state where the jobsite is located has an EMR rating system, provide the state EMR for the past three (3) years and the total hours worked.		
	Year:	EMR:	Hours Worked:
	Year:	EMR:	Hours Worked:
	Year:	EMR:	Hours Worked:
		3-year average:	
2.	**Total Recordable Case (TRC) and Days Away/Restricted/Transferred Case (DART) Rates**		
	List the cumulative injury statistics rates for the past three (3) years using the BLS formula to determine recordability.		
	Year:	TRC: DART:	Hours Worked:
	Year:	TRC: DART:	Hours Worked:
	Year:	TRC: DART:	Hours Worked:
		3-year average TRC: DART:	
	Attach copies of the OSHA Annual Summary Logs (OSHA's Form 300A) for the three most recent years and a current year OSHA 300 Log for the months during the period since the last annual report.		
	Any OSHA fine(s) over the past three (3) years? If yes, provide a written explanation on an attachment to this form.		
3.	**Fatalities**		
	Any fatalities within the last three (3) years? If Yes, list total number of fatalities: , and provide a written explanation for each fatality on an attachment to this form.		

4.	**Bureau of Alcohol, Tobacco, and Firearms violations**
	Any Bureau of Alcohol, Tobacco, and Firearms violations within the last three (3) years? If Yes, list the number: , and type of violations: .
5.	For companies exempt from record keeping requirements per 29 CFR 1904.1 (ten or fewer employees), complete items 1 and 3 above and summarize the cause of the injuries/illnesses for the past three (3) years, including the current year, on a separate attachment to this form. Additionally, include corrective actions taken to prevent re-occurrence.
6.	Check your type of work for the most recent 3 year period: ☐ Non-Residential Building, include dates: ☐ Heavy (Non-Highway) Construction, include dates: ☐ Mechanical, include dates: ☐ Electrical, include dates: ☐ Other (State type and date):
7.	List key Safety and Health personnel planned for this project. Please list name, expected position and safety performance on last three projects (Total Recordable Case and Days Away Restricted Transferred (DART) rates). Provide a resume if required by the Request For Proposal.

NAME	POSITION	PROJECT	TRC	DART

9.	**Environmental Record**
	Has your firm been subject to any environmental enforcement proceedings before a federal or state agency within the last five (5) years? If Yes, for each proceeding: provide the name of the agency, the nature of the proceeding, the charge(s), and the result on an attachment to this form.
	Has your firm violated or exceeded any federal or state environmental standard, requirement, regulation or statute within the last three (3) years? If Yes, for each violation give a brief description of the nature of the violation on an attachment to this form.

NOTE: This form is for evaluation purposes only and will not be a part of a Subcontract.

Attachment 3

VEHICLE BARRIER BUDGETARY ESTIMATE FOR COMMERCIAL GRADE DEDICATED SYSTEM

TOTAL BUDGETARY ESTIMATE FOR DELIVERY OF COMMERCIAL GRADE DEDICATED VEHICLE BARRIER, INCLUDING $300,000 FOR PURCHASE OF K-12 MATERIALS. INSTALLATION WILL BE BY OTHERS. ALL ITEMS LISTED IN SCOPE SECTION OF THE RFI IS INCLUDED.	________________

Critical Bounding assumptions for Budgetary Estimate:

Seismic Power Cutoff System Budgetary Estimate for Commercial Grade Dedicated System

TOTAL BUDGETARY ESTIMATE FOR DELIVERY OF COMMERCIAL GRADE DEDICATED SEISMIC POWER CUTOFF SYSTEM (SPCS), INCLUDING $50,000 FOR PURCHASE OF SPCS COMPONENTS. PURCHASE AND INSTALLATION OF CONCRETE STRUCTURE WILL BE BY OTHERS. INSTALLATION OF COMPONENTS OF THE SPCS WILL BE BY OTHERS. ALL ITEMS LISTED IN SCOPE SECTION OF THE RFI IS INCLUDED.	________________

Critical Bounding assumptions for Budgetary Estimate:

Attachment 4

Failure Modes and Effects for Seismic Power Cutoff System

Insert document 11-001-FMEA-001, Revision 0

WEIDLINGER-NAVARRO JV NORTHERN NM

Failure Modes and Effects Analysis of Seismic Power Cutoff System for the TA-63 TRU Waste Facility Project Phase B Design

11-001-FMEA-001, Revision 0

September 11, 2012

Prepared for
Los Alamos National Laboratory
Los Alamos, New Mexico 87545

Reviewed Classification/UCNI

(Reviewed By)

121142
Z#

9/27/12
(Review Date)

UNCLASSIFIED
(Classification)

WEIDLINGER-NAVARRO JV NORTHERN NM

Failure Modes and Effects Analysis of Seismic Power Cutoff System for the TA-63 TRU Waste Facility Project Phase B Design

11-001-FMEA-001, Revision 0

Prepared for: Los Alamos National Laboratory
P. O. Box 1663
Los Alamos, New Mexico 87545

Prepared by: Weidlinger-Navarro Northern New Mexico JV
4200 West Jemez Rd., Ste. 301
Los Alamos, New Mexico 87544

Contract 75181-000-09

Approvals:

JaKael Luey, PE, Engineering Manager — 9/25/2012 Date

Brian Sullivan, Project Manager — 9/21/12 Date

Executive Summary

The Seismic Power Cutoff System (SPCS) is a safety-class system designed to isolate electrical power from the Transuranic Waste Facility (TWF) storage buildings, characterization trailers and exterior site lights which are adjacent to a storage building or trailer during a seismic event. This analysis satisfies the requirement for a documented Failure Modes and Effects Analysis (FMEA) of safety-class systems. The FMEA includes both single-failure and design-basis accident-failure analyses to determine what failure modes, if any, can prevent the system from performing its safety function.

The SPCS is comprised of two identical, redundant and independent "channels". Each channel includes a Seismic Switch, Power Cutoff Contactor, Isolation Fuse Enclosure, Inertia Block and Reinforced Concrete Wall. Independence of redundant channel is obtained via physical and electrical separation of all safety class components. Each channel is capable of independently performing the safety function.

The FMEA is a qualitative analysis used to determine whether any violations of the single-failure criterion exist. It examines both component failures and failures resulting from design basis accidents. The SPCS is found to meet the independence and redundancy requirements. Likely failure modes result in the system being in a safe state. Each redundant channel includes a strobe light which aids in the detection of these failures. Extremely unlikely failure modes can only be detected during periodic maintenance and inspection activities.

Finally, the critical characteristics and recommended design features of the SPCS are identified. The critical characteristics of equipment anchorage, component ratings and requirements and redundant channel separation are among the items listed. It is recommended that a Commercial Grade Dedication Plan be developed to ensure that equipment is procured, tested and installed with these critical characteristics.

Contents

Appendices

List of Table

List of Trademarks

ANSI	Registered trademark of the American National Standards Institute, Inc.
IEEE	Trademark of the Institute of Electrical and Electronics Engineers, Incorporated.
UL	Registered trademark of Underwriters Laboratories, Inc.

1.0 Introduction

The Transuranic Waste Facility (TWF) Project Preliminary Safety Design Report has identified an increased potential for electrical fires during and after a seismic event. The postulated worst-case fire results in a release of radioactive material to the environment. Therefore, a safety-class, Management Level (ML)-1, Seismic Power Cutoff System (SPCS) is included in the design. The safety function of the Seismic Power Cutoff System is to isolate electrical power from storage buildings, the characterization trailers and the exterior site lights which are adjacent to a storage building or trailer during a design-basis seismic event, thereby preventing electrical fires that result from seismic collapse of TWF structures and involve material at risk (MAR).

Per the Los Alamos National Laboratory's (LANL's) *Engineering Standards Manual* (ESM) (ISD 341-2), design of safety-related instrumentation and control systems must incorporate sufficient independence, redundancy, diversity, and separation to ensure that all safety-related functions associated with such equipment can be performed under the postulated accident conditions identified in the safety analysis. Similarly, U.S. Department of Energy Order DOE O 420.1B, *Facility Safety*, requires that safety class electrical systems be designed to preclude single point failures. This evaluation is intended to establish conformance with this requirement. It uses the methods for single-failure analysis in the application of single-failure criterion provided in *IEEE Standard Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems* (IEEE Std 379) and *IEEE Standard Criterion for Independence of Class 1E Equipment and Circuits* (IEEE Std 384).

A previous revision (Rev. C) of this report included a comparison of two functionally equivalent but fundamentally different Seismic Power Cutoff Systems. The purpose of the comparison was to provide an objective analysis which was used to select which system would be best suited for use as a safety class system. This revision includes an analysis of the SPCS that was selected during that process.

The SPCS drawings include:

1. Drawing C55446 Sheet E-4001, Enlarged Electrical Plan, shows the boundaries of the safety system, critical dimensions and general component layout.
2. Drawing C55446 Sheet E-3002, Electrical Section Views, shows the enclosure and conduit mounting elevation views.
3. Drawings C55446 Sheets E-6004 and E-6006, Seismic Power Cutoff System Contactors A and B Schematic Diagram, shows the SPCS sequence of operation.
4. Drawings C55446 Sheets E-6005, Seismic Power Cutoff System Interconnection Diagram, shows the boundaries of the safety and component wiring interfaces.

Appendix A includes vendor data for commercial components which meet the functional requirements of the SPCS.

Appendix B includes the Failure Modes and Effect Analysis (FMEA) for the SPCS. This is a single-failure analysis of component-level failures and failures resulting from the design-basis accidents, which include fire, vehicle impact, and building collapse.

1.1 Methodology

The methodology used in the Failure Modes and Effects Analysis follows the procedures and requirements presented in *IEEE Standard Application of the Single Failure Criterion* (IEEE Std 379) and *IEEE Standard Requirements for Reliability Analysis in the Design and Operation of Safety Systems for Nuclear Facilities* (IEEE Std 577). The FMEA is a qualitative analysis used to determine whether any violations of the single-failure criterion exist in the design. This is not a quantitative analysis or probabilistic assessment as there is no requirement for these types of analyses in either IEEE Std 379 or IEEE Std 577.

The Preliminary Safety Design Report states that the safety function of the SPCS is to isolate electrical power from "storage buildings, the characterization trailers and the exterior site lights which are adjacent to a storage building or trailer during a design-basis seismic event, thereby preventing electrical fires that result from seismic collapse of TWF structures and involve MAR." Per the procedure it is necessary to identify system level protective actions that are available to accomplish the safety function. These protective actions are discussed in Section 2.0.

There are two safety groups that will adequately perform the required safety function. These safety groups are hereafter referred to as "channels". A "channel" is an arrangement of components as required to generate a single protective action. The SPCS design includes two identical and redundant channels each capable of performing the safety function.

The FMEA postulates various component level and design basis failures. The purpose is to verify that independence of the redundant channels is maintained. When the channels are verified as having no shared points of vulnerability and acceptable separation then independence is verified. It is recognized that the following conditions should be implicit in the design of these redundant channels. The focus of the analysis is to ensure these conditions are considered.

1. Independence and Redundancy: No single failure of a component will interfere with the proper operation of an independent redundant component or channel.
2. Non-detectable Failure: When non-detectable failures are identified then the preferred course of action is to redesign the system to make the failure detectable. Detectability is a function of system design and specified tests. Failures which cannot be revealed by alarm or anomalous indication or detected through periodic testing are not detectable.
3. Cascaded Failures: When the design is such that additional failures could be expected from the occurrence of a single failure then these failures are collectively considered to be a single failure.
4. Design Basis Events: When analysis indicates that failures in a safety system result from design basis events, these failures are considered as a consequence of the event.
5. Common Cause Failures: When common cause failures are identified they are treated as single failures.

2.0 Description of the SPCS

The drawings of the SPCS show the physical layout of components and electrical schematics and interconnection diagrams. Safety system boundaries and isolation devices are shown. Project drawing C55443-E-6000 is the Electrical Power One-Line Diagram which shows the location of the SPCS (Contactors A and B) within the distribution system wiring.

The SPCS system is comprised of two identical redundant channels each capable of performing the safety function. Each channel includes the following safety-class components: one Power Cutoff Contactor; one Seismic Switch, and one Isolation Fuse Enclosure. The components of each channel are mounted on separate and independent, reinforced concrete inertia blocks and support pads. A reinforced concrete wall is placed around the perimeter of the inertia block to protect the SPCS components against wind-driven missiles.

2.1 Power Cutoff Contactor

Each Power Cutoff Contactor is wired in series with the electrical feeder that supplies panelboard PP-B. Panelboard PP-B provides power to the storage buildings, the characterization trailers and the exterior lights which are adjacent to a storage building or trailer. Removing power to panelboard PP-B is sufficient to perform the safety function.

The function of the Power Cutoff Contactor is to open during a seismic event. Under normal operating conditions the contactor is closed. The contactor is held closed by the magnetic force created by the hold-in solenoid which is energized via the Seismic Switch. De-energizing the hold-in solenoid removes the magnetic force and allows gravity to act on the mass of the contactor and it will drop open. This is a safe state as all power is interrupted to panelboard PP-B when either Channel A or Channel B contactor opens.

Each Power Cutoff Contactor has auxiliary contacts which are used to illuminate a strobe light whenever the contactor is opened (i.e., de-energized). The strobe light is mounted to the Isolation Fuse Enclosure.

Each Power Cutoff Contactor is enclosed in a NEMA Type 4 metallic enclosure. The enclosures are anchored to the reinforced support walls using post-installed anchors. The contactors are protected from windborne projectiles by a reinforced concrete wall which goes around the perimeter of each inertia block.

Each Power Cutoff Contactor has two interfaces with the non-safety electrical distribution system. These interfaces are the line side and load side connections of the 480VAC feeder that goes from the utility building to panelboard PP-B. This non-safety class power wiring is "associated by proximity" with the contactor hold-in solenoid therefore a minimum separation distance is required. Line and load side wiring is delivered to the Power Cutoff Contactor through metallic conduit that is sleeved through the inertia block and anchored to the reinforced walls using post installed anchors. Therefore there will be no relative motion between the conduit and power cutoff contactor and rigid conduit is acceptable.

The Power Cutoff Contactor system level protective action is that when the hold-in solenoid is de-energized the contactor opens.

2.2 Seismic Switch

Each Seismic Switch includes a seismic sensor that detects seismic ground motion. The sensor is a triaxial accelerometer that can detect seismic motion in three orthogonal axes. The seismic sensor is a microcontroller that stores setpoints (trip levels) for each of the three axes in non-volatile memory. The accelerometers which are part of the seismic sensor are constructed using MEMS technology (microelectro/mechanical system) and are maintenance free. When seismic motion above the setpoint is detected the seismic sensor energizes an alarm relay which interrupts power to the hold-in solenoid of the cutoff contactor. Each seismic sensor has a self check feature which deenergizes a trouble relay and interrupts power to the cutoff contactor hold-in solenoid if the self check is not satisfied.

Each Seismic Switch includes a power supply which converts the incoming 120VAC line power to the 12VDC required to operate the seismic sensor, alarm and trouble relays. The power supply includes a battery and battery charging system. The function of the battery is to provide a minimum of 8 hours backup power to operate the Seismic Switch and alarm relay in the event of a power failure. Each power supply has a self check feature which deenergizes a trouble relay and provides power to a strobe light if the self check is not satisfied. Thus for a limited number of local power loss scenarios (i.e., local loss of 120VAC to the power supply input) the Seismic Switch will remain operable using battery backup for approximately 8 hours. During that time the strobe light will be lit. When the battery has discharged and the seismic sensor becomes inoperable then the seismic sensor self check will fail and the trouble relay will interrupt power to the cutoff contactor hold-in solenoid.

Each Seismic Switch is enclosed in a NEMA Type 4 metallic enclosure. Each seismic switch is bolted to the enclosure baseplate. The baseplate is anchored to a reinforced concrete pedestal using post installed anchors per the manufacturers' instructions. The Seismic Switches are protected from windborne projectiles by a reinforced concrete wall which goes around the perimeter of each inertia block.

The Seismic Switches do not interface with any non-safety systems or components.

The Seismic Switch system level protective actions are:

- Detect ground motion over the acceleration and frequency spectrum for the associated setpoint and change the state of the alarm relay.
- Perform a self check of the seismic sensor operability and change the state of the trouble relay in the event that the sensor is inoperable due to internal failure or external power loss.

2.3 Isolation Fuse Enclosure

Each Isolation Fuse Enclosure includes a fuse. The fuse provides the required isolation between the non-safety electrical distribution system and the safety class SPCS. The system level protective action of the fuse is to prevent electrical faults from damaging SPCS components in such a manner as to inhibit the SPCS safety function.

Each Isolation Fuse Enclosure includes a surge protection device. The system level protective action of the surge protection device is to prevent damage to SPCS components from transient voltages.

Each Isolation Fuse Enclosure is a NEMA Type 4 metallic enclosure. These enclosures are anchored using post-installed anchors to the reinforced concrete wall which goes around the perimeter of the inertia block

A strobe light is included. The function of the strobe light is to illuminate and alert operators that the Power Cutoff Contactor is not closed and therefore power to panelboard PP-B has been interrupted. The strobe light will also illuminate and facilitate the method of detection for some power loss and internal failure scenarios. The strobe light signal does not have a safety function.

2.4 Component Summary Table

Table 1 summarizes the manufacturer's information, safety classification, and function of the components that were used as the basis of the SPCS design. The items listed in Table 1 meet the functional requirements of the system, but have not been qualified for use as safety class components. A Commercial Grade Dedication Plan will be developed to ensure that each component possesses the critical characteristics identified in Section 4.0. Vendor data for the equipment is provided in Appendix A. Table 1 lists the components for one of the two identical redundant channels.

Table 1. Seismic Power Cutoff System Component Summary. (2 sheets)

Item	Specification/ Drawing	FMEA Equipment Basis: Manufacturer's Part Number or Referenced Standard	Classification	Safety Function
Power Cutoff Contactor	26 2830	Eaton XTCEC10N	Safety-Class ML-1	Open prior to SDC-2 seismic event in response to seismic switch alarm output and remain open through SDC-3 seismic event.
Seismic Switch	26 2931	Earthquake Safety Systems, Apollo 2100	Safety-Class ML-1	Detect seismic event prior to SDC-2 and operate alarm output.
Isolation Fuse Enclosure	26 2931	UL 508 Fabricated Enclosure	Safety-Class ML-1	Protect safety class components from electrical faults and transients.

Table 1. Seismic Power Cutoff System Component Summary. (2 sheets)

Item	Specification/ Drawing	FMEA Equipment Basis: Manufacturer's Part Number or Referenced Standard	Classification	Safety Function
Conduit	26 0533	Rigid Metal Conduit UL 6	Safety-Class ML-1	Maintain integrity through SDC-3 seismic event.
Anchors	Preapproved by LANL	Drillco Post Installed	Safety-Class ML-1	Remain attached to reinforced wall through SDC-3 seismic event.
Non Safety Conductors that Interface with Safety System Components	C55443 Sheet E-4001	IEEE Std 383 Flame Propagation Rating	Safety-Class ML-3	Maintain integrity through SDC-3 seismic event.
Inertia Block	03 3001	--	Safety-Class ML-1	Provide mounting pedestal for seismic switch which is responsive to ground motion prior to SDC-2 event.
Reinforced Wall	03 3001	--	Safety-Class ML-1	Provide rigid structure to support SPCS components which will not collapse or suffer major deformation during ground motion through an SDC-3 event.

3.0 Failure Modes and Effects Analysis of SPCS

The FMEA is a qualitative analysis used to determine whether any violations of the single-failure criterion exist in the design. The analysis is intended to establish independence by systematically investigating potential failures. There are two parts to the FMEA. The first part addresses potential failures of specific components or systems. The second part addresses potential failures resulting from design-basis accidents. Appendix B contains the FMEA for the SPCS.

Each of the potential failures is assigned a unique ID which has no relevance other than providing a convenient means of identifying any particular failure scenario. The component/system and function are identified. The potential failure mode, causes and effects are postulated. In general there are only two effects; either the system fails in a safe state or the safety function of one of the redundant channels is compromised.

Each failure is assigned a severity index which ranges from 0 to 9. A severity index (S) of 0 represents a failure mode with an inconsequential effect on the ability of the system to perform its safety function. All safe state failures are assigned a severity index of 0.

A severity index of 9 represents a failure mode that has catastrophic effects on the ability of the system to perform its safety function. Any failure with the potential to affect both redundant channels is assigned a severity index of 9. Any failure that is deemed independent in that it only affects one of the redundant channels is assigned a severity index of 5.

Each failure is assigned an occurrence index (O) which ranges from 1 to 10. An occurrence index of 1 represents an unlikely failure mode. An occurrence index of 10 represents an inevitable failure mode. Selecting the occurrence index is a subjective judgment that is influenced by the safeguards designed into the system. Safeguards that decrease the likelihood of the any potential failure are listed. Safeguards become the seeds for the critical characteristics that are listed in Section 4.0.

Several failures are identified that could result in the disability of one or both redundant channels to perform the safety function. All of these failures are judged to be unlikely. An explanation of the rationale behind this judgment is provided in Section 3.1.

The product of the severity index and the occurrence index (SO) is an indication of the relative risk associated with any particular failure.

The method of detection for each failure is listed. SPCS component failures are detected by one of the methods or a combination of the methods listed below:

1. Strobe light activation.
2. Periodic inspection and testing.
3. Observation of power outage.

The system is designed so that the effect of likely failures is that the Power Cutoff Contactor will open. The means of detection of these failures is primarily the strobe light and that personnel will notice the power outage. Improbable failure modes are only detectable via period inspection.

3.1 FMEA Results Discussion

3.1.1 Safe State Failures

The system is designed so that common failures result in a safe state. These types of failures are identified in the FMEA Table (Appendix B) as those with a severity index of 0. Component failure ID C1, C3, C7, C9, C12, C14, C16, C17, and B1 are all safe state failures. The single failure criterion is met and no further analysis is required.

3.1.2 Loss of Safety Function in Single Channel

The FMEA identifies some failure modes which have a potential to inhibit the ability of one of the redundant channels from being able to perform the safety function. These failures are identified in the FMEA Table (Appendix B) as those with a severity index of 4. Component failure ID C5, C6, C8, C10, C11, C13, C15, C18, B4, and B5 are this type of failure. Satisfaction of the single failure criterion for these failures requires that they be independent failures. The following descriptions explain the independence of these failures. The means of detection for these failures is periodic testing or inspection.

- Failure ID C5 is the scenario where one of the redundant channels becomes inoperable due to random Seismic Switch component failure. This is not common cause failure with respect to the Seismic Switch in the redundant channel. The single failure criterion is satisfied. Note that Failure ID C4 addresses a similar more severe version of this scenario where there is a common cause failure mechanism (e.g., environment) that prevents both channels from performing the safety function.
- Failure ID C6 is the scenario where one of the redundant channels becomes inoperable due to incorrect firmware or calibration data being loaded into the Seismic Switch. Factory testing, shaker table setpoint testing and startup testing will be performed to ensure that setpoints are correct. Seismic Switches will be protected from tampering and configuration control will be maintained to ensure setpoints are not altered. This is not a common cause failure therefore the single failure criterion is satisfied.
- Failure ID C8 and C11 are the scenarios where electrical contacts become stuck or welded shut. The contacts can either be the 120VAC contacts on the Seismic Switch alarm or trouble relays or the 480VAC contacts on the Seismic Power Cutoff Contactor. Seismic Switch alarm and trouble relays are specified with ratings sufficient to operate the contactor hold-in solenoid. The Power

Cutoff Contactor is specified with rating sufficient to interrupt the estimated peak demand. This is not a common cause failure therefore the single failure criterion is satisfied.

- Failure ID C10, C13, C15, and C18 are the scenarios where a mechanical failure or electrical short occurs somehow inhibits the safety function. Survivability testing simulates ground motion of the design basis earthquake and is performed on all components. Physical separation between redundant channels eliminates a common cause. This is not a common cause failure therefore the single failure criterion is satisfied.
- Failure ID B4 and B5 are the design basis accident scenarios where one channel suffers mechanical damage from a runaway vehicle or being crushed by building rubble. Safety class bollards are placed around the equipment and redundant channels are physically separated. This is not a common cause failure therefore the single failure criterion is satisfied.

3.1.3 Loss of Safety Function in Both Channels

The FMEA identifies some failure modes which have a potential to compromise the safety function of both redundant channels. These failures are identified in the FMEA Table (Appendix B) as those with a severity index of 9. Component failure ID C2, C4, B2, and B3 are this type of failure. These failures cannot be shown to meet the single failure criterion as there is a common cause which could impact both channels.

IEEE Std 379 allows particular failures to be excluded from the single failure analysis provided reliability analysis, probability assessment, operating experience, engineering judgment or any combination thereof, are used to establish a basis for excluding that particular failure. The following presents the basis for excluding these failures from the single failure analysis. The means of detection for these failures is periodic testing or inspection. The periodic testing and inspection cycle recommend in Section 5.0 is sufficient to detect these failures.

- Failure ID C2 is the scenario where an overvoltage electrical transient or lightning surge originates in the non-safety power panel which is common to both redundant channels of the SPCS. The transient overvoltage damages both seismic sensors in such a manner that they do not function. The alarm relay outputs are failed low and the trouble outputs are failed high.

  The surge protection installed in the Isolation Fuse Enclosure helps reduce the probability of this scenario by limiting the let through energy and clipping the peak voltage of any transients on the incoming branch circuit. The incoming branch circuits are underground and relatively short and this limits the exposure to transients induced by ground currents caused by lightning. The SPCS branch circuits have low available fault currents (<2000A) and are supplied by a UPS which further reduces fault current and provides isolation from transient over voltages. These factors make it extremely unlikely that a transient overvoltage could simultaneously affect both channels.
- Failure ID C4 is the scenario where environmental extremes cause common failures in both redundant channels. The common failure prevents both channels from performing the safety function. The environmental extremes could be overheating or freezing.

  Components are rated to operate in the temperature range of -20°C to 60°C. Enclosures are NEMA 4 and provide protection against water and dust. These factors reduce the chance that a common failure would occur in both channels within the same inspection and testing cycle. The likelihood of this type of failure is further reduced by that fact that the vast majority of failures that would occur as a result of temperature extremes are safe state failures. These factors make it extremely unlikely that environmental extremes could simultaneously damage both channels.
- Failure ID B1 and B2 are the design basis accident scenarios where both channels are damaged as a result of being engulfed by fire. The fire is assumed to damage both channels in such a manner

as to disable the safety function. There is a minimum separation of the redundant channels. This makes it extremely unlikely that a single fire can affect both channels simultaneously.

4.0 Critical Characteristics

All components of the SPCS are commercial-grade items that are not subject to design or specification requirements unique to nuclear facilities. As such, a plan of how these items will be certified for use as safety-class, management-level components must be documented. The intent is that the items are ordered from the manufacturer or supplier on the basis of specifications set forth in the manufacturer's published product descriptions. Certification of items will be via the requirements of the Commercial Grade Dedication Plan. This section includes a list, by component, of specific attributes or tests which are recommended to be included or addressed in the Commercial Grade Dedication of the system.

Each safety class component has critical characteristics which are identifiable and measurable properties or attributes of an item that are critical to the item performing its safety function or can be used to provide assurance that the item received is the item specified. Critical characteristics include those properties or attributes that define an item's form, fit, and function essential to performing its safety function.

4.1 Inertia Block, Reinforced Wall, Mounting and Anchorage

Block wall, concrete base and equipment anchors will conform to the following:

- Concrete: The mix design shall comply with LANL specifications and be tested for compressive strength. Inspections for cracking and honeycombing shall be performed.
- Rebar: Reinforcing Steel: ASTM A 615, Grade 60 deformed bars and stirrups shall be used. Fabricate concrete reinforcing in accordance with CRSI Manual of Practice. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete. Verify that concrete cover for reinforcement conforms to the drawings.
- Post Installed Anchor Bolts: For all electrical enclosures and conduit straps use only post installed anchors which are preapproved by LANL and included in LANL's ESM (ISD 341-2, Chapter 5, "Structural," Section III, Appendix B). This is the Drillco Maxi-Bolt for PC-3 and PC-4.

4.2 SPCS Redundant Channels and Separation

SPCS redundant channels must be independent and adequately separated:

- Redundant channels must be separated by 20 ft minimum with no intervening combustibles. The purpose of this requirement is to maintain independence (LANL's ESM, ISD 341-2, Chapter 8, "I&C").
- Redundant channels must be separated from any building not designed to withstand a Seismic Design Category (SDC)-3 event by a distance at least equal to the height of the building, or it must be demonstrated that it is not credible that the building could collapse in a manner to damage either redundant system.

4.3 SPCS Electrical Enclosures, Wiring and Conduit

- Power Cutoff Contactor, Seismic Switch and Isolation Fuse Enclosures shall be qualified/certified to operate in a mild environment that is unroofed. Certification shall ensure that components are designed to operate in the following environment:
    - Ambient temperature range: 5 to 89°F.
    - Altitude: 7500 feet above sea level.
    - Solar heat gain: 110 W/ft^2.
- Individual components must be listed by nationally recognized testing laboratory as suitable for use in an outdoor environment. Enclosures must be dust tight and water tight. NEMA 4 or equivalent is acceptable.
- Electrical Conduit shall be rigid steel conduit which meets the requirements of ANSI C80.1-2005 and UL 6-2000.
- Electrical Conduit located entirely in the safety boundary shall be installed and anchored to the reinforced concrete wall in such a manner as to ensure that there is no relative motion between the conduit and safety system enclosures during an SDC-3 seismic event. No flexible conduit is required.
- All terminations are made per manufacturers torque specs using approved/calibrated tools.
- Non-safety electrical conductors that interface with the safety system electrical components shall be copper and shall meet the fire propagation requirements of IEEE Std 383.

4.3.1 Seismic Switch

- The enclosure will be bolted to a manufacturer supplied baseplate which is anchored using post-installed anchors to an 8–in. pedestal that is an integral part of the reinforced concrete inertia block. Installation shall conform to the manufacturers recommended best practices.
- Setpoint and Survivability Testing is summarized in Section 4.4.
- Internal relays shall be rated with adequate capacity to operate the Power Cutoff Contactor hold-in solenoid.
- Software/Firmware quality assurance plan shall be developed to be consistent with the requirements of DOE G 414.1-4, *Safety Software Guide for Use with 10 CFR 830, Subpart A, Quality Assurance Requirements, and DOE O 414.1C, Quality Assurance.*

4.3.2 Power Cutoff Contactor

- The Contactor is required to have a continuous current rating sufficient to carry the required load current.
- The Contactor will be subjected to the Survivability Testing summarized in Section 4.4.

4.3.3 Isolation Fuse Enclosure

- Isolation devices (fuses) are required to meet the requirements listed in IEEE Std. 384 Section 7.1.2.43; provide design overcurrent protection for the life of the device, fuse time-overcurrent trip characteristic for all circuit faults shall cause the fuse to open prior to opening any upstream device (i.e., coordinated), and the power source shall have the capacity to supply the necessary fault current to ensure proper coordination without loss of function of the Class 1E load.

- Isolation Fuse Enclosures in redundant channels cannot be powered from the same branch circuit in order to reduce the likelihood of failure C2.
- Isolation fuse shall have a continuous current rating which is sufficient to carry the required load current.
- Isolation Fuse Enclosure shall be provided with a Type 4 UL 1449 3rd Edition surge protection device.
- The Isolation Fuse Enclosure will be subjected to the Survivability Testing summarized in Section 4.4.

4.4 Shaker Table Testing of SPCS Components

- Setpoint Testing: Seismic Switch qualification testing shall demonstrate that the setpoint is such that it will perform the safety function at or below the response spectrum of an SDC-2 event. For the purposes of setpoint testing the safety function is that the seismic switch alarm relay changes state when the setpoint is exceeded.
- Survivability Testing: Seismic Switch, Isolation Fuse Enclosure and Power Cutoff Contactor qualification testing shall demonstrate the equipments ability to perform the safety function during and after the time it is subjected to the forces resulting from the Site Wide Free Field Surface Response Spectra presented in LANL's ESM (ISD 341-2, Chapter 5, Section III, Figures III-1 and III-2) (5% damping). For the purposes of survivability testing the safety function of all components is that no component will fail in an un-safe state or break loose from its anchorage:
  - Output relays cannot change state or "chatter". This includes the main contacts on the Power Cutoff Contactor.
  - Internal wiring cannot slip or break loose.
  - Internal components cannot dislodge or break loose from mounts.
- Shake table testing of components shall conservatively simulate the vibratory motion postulated at the equipment mounting during an earthquake as described in *IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations* (IEEE Std 344). The response spectra referenced in #2 above can be used as the Required Response Spectra (RSS) for IEEE Std 344 testing.

5.0 Recommendations

1. The following TSR inspections and tests are recommended.
   a. Full function and full inspection of all components of both channels of SPCS once per year. Outage required.
   b. Inspection of Seismic Switch only once per year scheduled 6 months after full function test and inspect. Minimal PPE required for inspection of energized Seismic Switch interior.
   c. Replace Seismic Switch Battery every three years.
2. It is recommended that additional fire watches will be set during SPCS outages.
3. Develop Commercial Grade Dedication Plan per the recommendations in EPRI-5652, *Standard for Commercial Grade Dedication.*

6.0 References

ANSI C80.1-2005, *American National Standard for Electrical Rigid Steel Conduit (ERSC)*, Published by National Electrical Manufacturers Association, Rosslyn, Virginia.

DOE G 414.1-4, *Safety Software Guide for Use with 10 CFR 830, Subpart A, Quality Assurance Requirements, and DOE O 414.1C, Quality Assurance*, U.S. Department of Energy, Office of Environment, Safety and Health, Washington, D.C.

DOE G 420.1-1, *Nonreactor Nuclear Safety Design Criteria and Explosives Safety Criteria Guide for Use with DOE O 420.1, Facility Safety*, U.S. Department of Energy, Office of Environmental, Safety and Health, Washington, D.C.

DOE O 420.1B, *Facility Safety*, U.S. Department of Energy, Washington, D.C.

Drawing C55443, Sheet E-E-3002, "Electrical Section Views," Revision 0, Weidlinger-Navarro Northern New Mexico JV, Los Alamos, New Mexico.

Drawing C55443, Sheet E-4001, "Enlarged Service Plan," Revision 0, Weidlinger-Navarro Northern New Mexico JV, Los Alamos, New Mexico.

Drawing C55446, Sheet E-6004, "Seismic Power Cutoff System Contactor A Schematic Diagram," Revision 0, Weidlinger-Navarro Northern New Mexico JV, Los Alamos, New Mexico.

Drawing C55446, Sheet E-6005, "Seismic Power Cutoff System Interconnection Diagram," Revision 0, Weidlinger-Navarro Northern New Mexico JV, Los Alamos, New Mexico.

Drawing C55446, Sheet E-6006, "Seismic Power Cutoff System Contactor B Schematic Diagram," Revision 0, Weidlinger-Navarro Northern New Mexico JV, Los Alamos, New Mexico.

EPRI-5652, *Standard for Commercial Grade Dedication*, Electric Power Research Institute, San Diego, California.

IEEE Std 344, 2004, *IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations*, Institute of Electrical and Electronics Engineers, New York, New York.

IEEE Std 379, 2000, *IEEE Standard Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems*, Institute of Electrical and Electronics Engineers, Inc., New York, New York.

IEEE Std 383, *IEEE Standard for Qualifying Class 1E Electric Cables and Field Splices for Nuclear Power Generating Stations*, Institute of Electrical and Electronics Engineers, New York, New York.

IEEE Std 384, 1992, *IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits*, Institute of Electrical and Electronics Engineers, Inc., New York, New York.

IEEE Std 577, 2004, *IEEE Standard Reliability Analysis in the Design and Operation of Safety Systems for Nuclear Facilities,* Institute of Electrical and Electronics Engineers, Inc., New York, New York.

LANL ESM, *Engineering Standards Manual*, ISD 341-2, Los Alamos National Laboratory, Los Alamos, New Mexico.

UL 6, *Rigid Metal Electrical Conduit,* Underwriters Laboratories, Inc., Northbrook, Illinois.UL 508, *Industrial Control Equipment*, Underwriters Laboratories, Inc., Northbrook, Illinois.

UL 1449, *Surge Protective Devices*, 3rd Edition, Underwriters Laboratories, Inc., Northbrook, Illinois.

Appendix A

SPCS Vendor Data

THE PROFESSIONALS IN SEISMIC PROTECTION SYSTEMS

ESS

EARTHQUAKE SAFETY SYSTEMS, INC.

www.eqsafetysys.com

APOLLO Series 2100 Seismic Switch

SHUT-IT-DOWN SAFELY & SECURELY With the APOLLO EMERGENCY SEISMIC SWITCH

Ideal for all critical Industrial Applications where accidental shutdowns cannon be tolerated, e.g.:

Valves, Solenoids and Actuators
Pipelines / Pumping Station
Electronic Security Doors
Process Control/ Systems
Hazardous Material / Chemicals
Motors, Elevators, etc.

DESCRIPTION:

A fully integrated industrial seismic switch with tri-axial digital seismic sensor ("P" & "S" waves) and minimum 8-hour reserve battery power. The monitor is shipped complete with pre-drilled base plate for easy installation. A NEMA-4 enclosure is shown to the right; NEMA-4X (stainless steel) above.

Seismic alarm and control setpoints (trigger values) are user selectable to local requirements. Outputs peak ground acceleration (PGA) values for all three axes in real-time for retrieval via RS-232C serial connection.

Internal terminal block provides simple field wiring terminations for AC power (110 Vac / 60 Hz standard), Level 1 Alarm, Level 2 Alarm, Loss of AC Alarm, Seismic Trip Alarm (all alarm output contacts are FORM C, rated at 230 Vac, 6A).

Options include: 230Vac / 50 Hz power supply, time history recording with digital recorder module.

FEATURES:

Powerful design features include multi-setpoint sensor control. Peak ground acceleration values output in real-time via simple RS-232C serial connection. Sensor self-diagnostics. Power-on self-test. On-board 8-hour battery back-up. Maintenance free solid-state tri-axial sensor provides unparalleled accuracy and reliability. Industrial quality NO / NC relay output (user selectable), 230Vac / 10A rated contacts. Easy field termination. Front panel (external) status lights and rugged Test/Reset switch. Fully assembled for fast installation. Electrician friendly with ample room for rigid or flex conduit termination.

When Earthquakes Strike .... Trust ESS ....

APOLLO Series 2100 Seismic Switch

SPECIFICATIONS

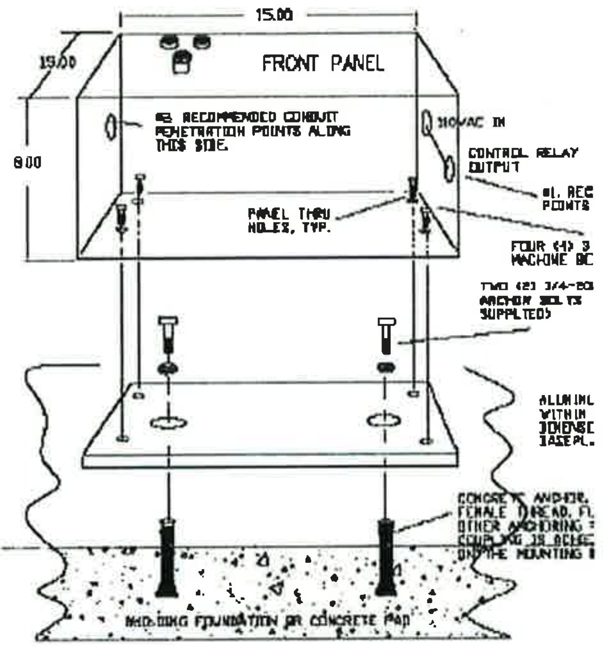
Seismic Standards:	Compliance with all nominated seismic standards is achieved with this intelligent and flexible, state-of-the-art technology.
Sensors:	Solid state, triaxial accelerometer in three orthogonal axes (X,Y & Z). Detects vertical "P" and horizontal "S" wave accelerations. Outputs *Peak Ground Acceleration* (PGA) values upon exceeding setpoint. Optional Digital Recorder Module available for time history waveform recording.
Frequency Response:	0.5Hz to 15Hz. Digital filter protects from industrial vibrations.
Setpoints:	User selectable from 0.025g to 0.5g on each axis (X, Y & Z).
Communications:	RS-232C serial connection
Diagnostics:	Self-diagnostics at power on and reset. Front panel visual indicators: "AC power on", "Level 1 Alarm", "Level 2 Alarm".
Control Outputs:	Multiple independent relays, user selectable from X, Y or Z axis. NO or NC (10amps. 250 VAC) dry, isolated contacts. Alarm relays are user-programmable for momentary or latching operation. Default configuration: following a system "trip" applicable control relays remain latched until reset by operator.
Power Supply (UL):	120 VAC, 50 / 60 Hz (Standard) or 220 VAC, 50 Hz (specify). Solar optional. Sealed, maintenance-free batteries, 8-hour capacity.
Physical:	Size, 15" W X 15" D X 10" H NEMA 4 standard. NEMA 4X stainless optional, 16" W X 16" D X 10" H Fully gasketed door Status indicators: Fault, A/C power loss, Seismic trip, AC Power "On" Operating temperature, -25° C to +70° C. Humidity, 0% - 100% (non-condensing). Weight, 35 lbs. including battery (approx).
Installation:	Via four (4) ¼" bolts attached to pre-drilled aluminum baseplate (provided with Apollo), mounted horizontally. Baseplate weight is 12 lbs. Panel may be wall-hung (requires external floor-mount sensor) in some circumstances (consult factory for details). Precise leveling not required. Baseplate mounted to concrete pad/floor via two anchor bolts.
Options:	Various custom logic schemes / redundancies using flow, pressure, leak detection & level monitoring sensors as a positive feedback. Digital Recording Module for time history records with event time-stamping.

*(Subject to change).

EARTHQUAKE SAFETY SYSTEMS, INC.
41710 Enterprise Circle South, Unit F
Temecula, CA 92590
(951) 543-2121, Fx (877) 538-1783
Website : www.eqsafetysys.com
email: info@eqsafetysys.com

STARTUP WORK PLAN – BEFORE ESS ARRIVES

MOUNTING:



1) The seismic sensor is integrally mounted within the APOLLO enclosure. Disconnect the green plastic mating connector from the seismic sensor and loosen the single mounting screw. Carefully remove the seismic sensor from the panel and set it aside in a SAFE/SECURE place along with the mounting screw & washer.
2) Remove the battery from the panel.
3) Remove the aluminum baseplate from the base of the enclosure. Keep the screws & washers for later use in Step #5.
4) The baseplate should be affixed to the building foundation or other structure representative of the input energy applied to the monitored process/equipment. For natural gas or water industry applications this is usually a building foundation or isolated concrete pad in order to monitor freefield ground acceleration. Concrete anchors are typically used to hold down the baseplate thru two (2) countersunk holes in the plate. 5/16" or 3/8" concrete anchors (not supplied) and associated bolts and washers are commonly used. Other anchoring methods may be used at the client's discretion (i.e. application of epoxy between the baseplate and the floor). It may be wall mounted in some circumstances- if preordered as a vertical unit with an external sensor. If the facility to be protected has a raised floor, a mounting pad (6" to 8") should be laid with the final pad at least 2" to 3" above ground level. Pads >4" above ground are not generally recommended but, have been observed in use. Care should be taken to restrain taller concrete masses ('old school' seismic pillars/blocks) from rocking. In any case, the mounting method should result in the sensor being coupled to a stable, large inertial seismic mass.
5) Securely fasten the APOLLO enclosure to the baseplate (SEE APPENDIX B) via four (4) holes in the base of the cabinet which line-up with the four tapped holes in the base plate. Use the screws & washers removed during step #3 above.

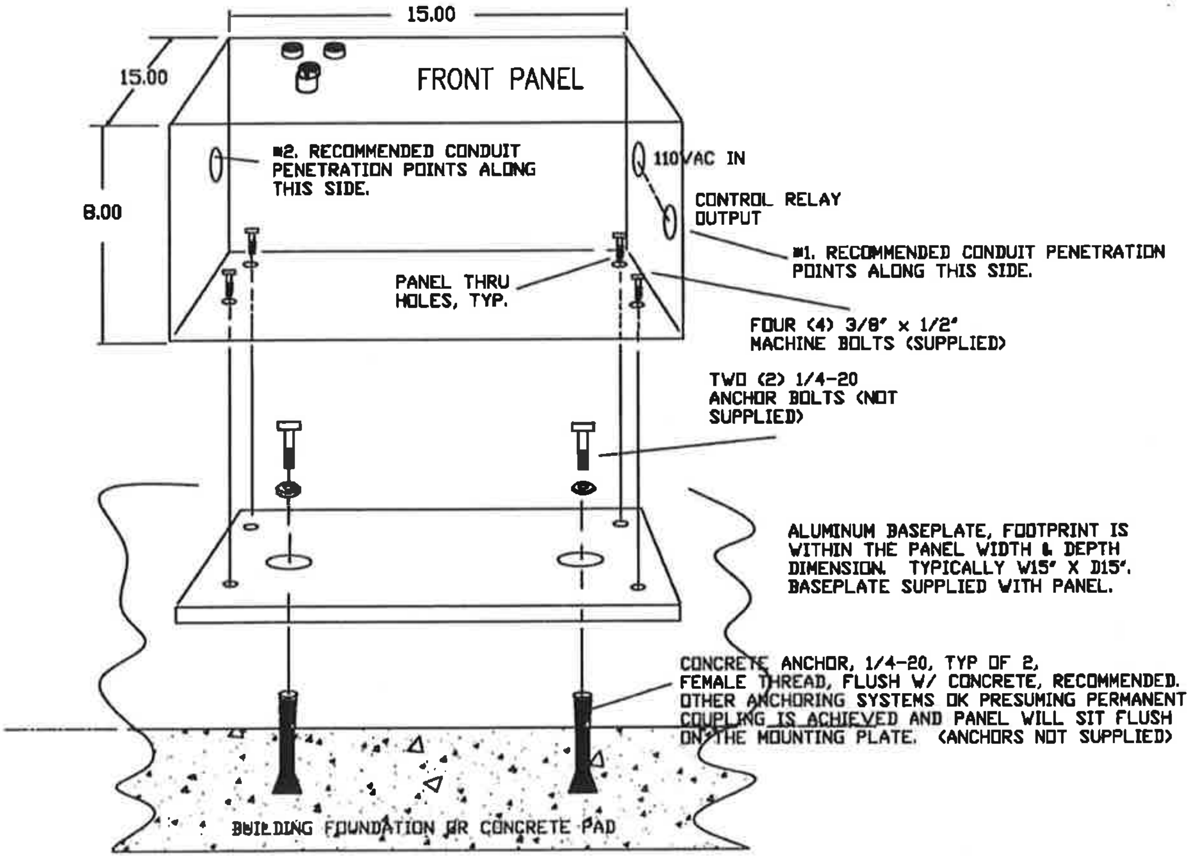
REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
B	TRANSCRIBED TO CAD WITH EDITS	8-15-05	RAM
C	OPT. ANCHORING REFERENCED.	6-1-07	RAM

Apollo 2100 Standard Installation Procedure (See Note 3 for optional mounting)

STEP #1
Secure the baseplate to the building foundation, concrete pad or other inertial seismic mass via concrete anchor bolts or other fasteners (not supplied).

STEP #2
Mount the Apollo 2100 to the baseplate with the bolts provided. All mounting holes are factory pre-drilled and tapped, as required.

Notes: unless otherwise specified
*1. 1st choice for conduit penetration.
*2. Alternative locations for conduit penetration.
3. For wall mounted cabinets, (non-standard, optional) attach cabinet to the wall at the desired height via uni-strut or equivalent hardware. The sensor is housed in a small separate enclosure with its own mounting tabs. Rigidly mount/affix the sensor enclosure to the foundation, concrete pad or other structure, such that, it is rigidly coupled to a large inertial seismic mass such as the building foundation, tank ringwall, etc.



TITLE APOLLO 2100 INSTALLATION, TYPICAL

DRAWN A.FLIG
DATE 11OCT04
SCALE NONE
APPROVED
CUST. P.O.#
CONFIDENTIALITY NOTICE: ALL INFORMATION ON THIS DRAWING IS PROPRIETARY TO THE PANEL SHOP
REV. C

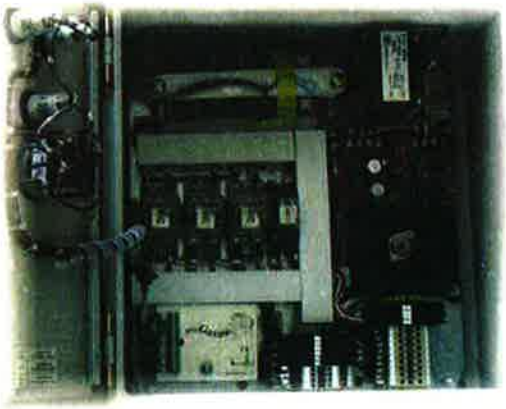
Earthquake Safety Systems
2550 Bay Vista Lane, Los Osos, CA 93402

DRAWING NO. 700388
SHEET 1 OF 1

7003888

CAD/CAM

ELECTRICAL:
A dedicated A/C power circuit (direct to main breaker) is recommended to avoid accidental power loss. The following instructions are general guideline procedures and should be performed by a qualified electrician trained in safe electrical practices & knowledgeable of applicable electrical codes.



1) Drill/punch entry holes for power and control wiring conduits at a convenient spot in panel enclosure. See sample photos below from other projects.
2) Pull the power and control cables into the APOLLO enclosure with sufficient service loop to effectively route, secure and terminate the wiring (i.e. approx. 5 feet).
3) Terminate the power wires in accordance with the wiring diagram supplied with the unit. DO NOT APPLY POWER YET. Verify enclosure is properly grounded for electrical safety. Remove any excess debris. Check and correct for any wiring short circuits.
4) Re-install the battery and secure with hold down restraints. Make sure all breakers are OFF (AC & DC). Connect leads to battery terminals – OBSERVE CORRECT POLARITY!! Verify that the +12V and COM- battery leads land at the correct terminals. Photos herein are EXAMPLE only. Examine your system and verify that the +12V battery lead goes to the +12V terminal on the power supply board (may be lifted for shipping). If the +12V lead is lifted and wire-capped that is OK. Leave it for the ESS technician to remove the wire-cap and land the lead.
5) With the APOLLO 110Vac breaker OFF, verify that 110Vac is present at the input to the breaker.

NOTE: STOP HERE IF FACTORY COMMISSIONING IS SCHEDULED

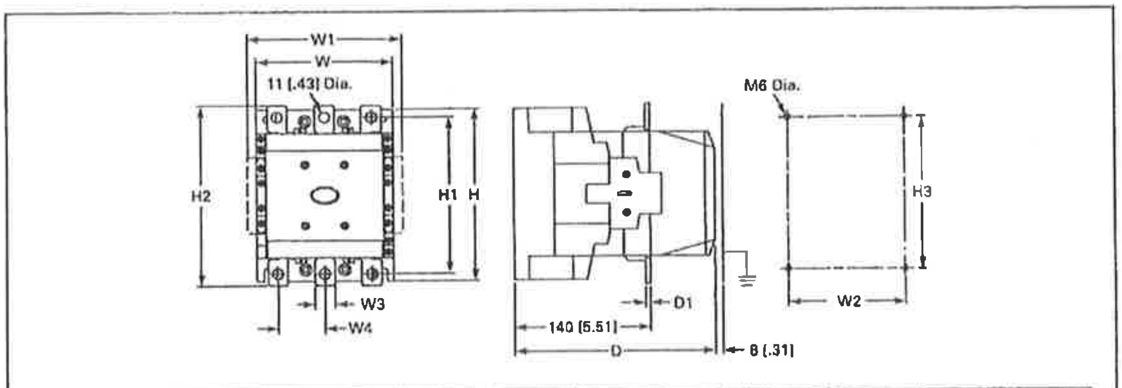
EARTHQUAKE SAFETY SYSTEMS INC.

www.eqsafetysys.com

STARTUP WORK PLAN – ESS & ACTUATOR TECH ACTIVITIES

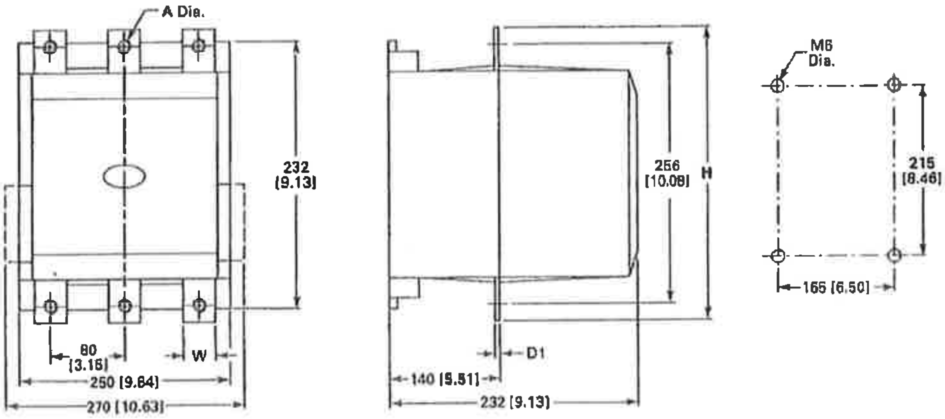
1) ACTUATOR tech can begin setting actuator limit switches or other controls. Disconnect the seismic sensor's green mating connector.
2) Check APOLLO panel wiring.
3) Trip the AC circuit breaker in the seismic panel ON. Verify presence of +12 Vdc (at the power supply board and at the +12V battery lead).
4) Land the BATT+ wire (either at the battery or at the power supply board, as required) in order to begin charging the batteries. Verify that the batteries begin charging.
5) Check APOLLO panel to actuator wiring with ACTUATOR tech. If the actuator and APOLLO are not very close to each other, radios will be helpful.
6) ACTUATOR tech to place the actuator at a mid-travel position.
7) Deliver power to the actuator.
8) ACTUATOR tech should place actuator in local and verify local actuator control.
9) ACTUATOR tech should place the actuator in remote and verify that a remote 'CLOSE CALL' command from the APOLLO drives the actuator in the close direction. Likewise, an 'OPEN CALL' command from the APOLLO should drive the actuator in the open direction.
10) Drive the actuator full close and verify proper close indication in the APOLLO panel (lights & relays).
11) Drive the actuator full open and verify proper open indication in the APOLLO panel.
12) Connect the seismic sensor and let it execute its power on self-test. After approximately 30 seconds the sensor will be ready to go. ESS' tech will review sensor operating parameters and log them; making any changes, as necessary.
13) Give the sensor a gentle shake and verify that a 'Seismic Trip' occurs. The actuator should turn the valve fully closed.
14) Re-install the seismic sensor module via the single mounting screw. The sensor mounting screw should be tightened FINGER SNUG via a small handtool just until the sensor module is immobilized. DO NOT OVER-TIGHTEN or damage may occur to the sensor module's plastic case or the internal electronic circuit board.
15) Reset the APOLLO via the RESET switch. Verify sensor and indicators clear.
16) Send the actuator a remote OPEN CALL command and verify that the actuator drives the valve fully open.
17) The system is now activated- waiting to trip on acceleration levels in excess of the programmed setpoints.

NOTE: The typical Apollo application involves solenoid operated devices or signals transmitted to a Fire Control or Building Management System. Therefore, the startup section pertaining to actuator control may not apply. In cases where the actuator is not directly controlled by the Apollo (i.e. solenoid power & control is not run through the Apollo alarm contacts) then, ESS' startup work is complete when the Apollo output alarm contacts are verified to change state. Modifications to the procedure generally occur at a 'tailgate' meeting at the start of the field work; based on input from facilities personnel, life safety systems personnel, the ESS technician and the actuator technician.



	W	W1	W2	W3	W4	H	H1	H2	H3	D	D1
Frame L **[185 – 250A]**	140 [5.51]	160 [6.30]	120 [4.72]	20 [.79]	48 [1.89]	180 [7.09]	184 [8.46]	189 [7.44]	160 [6.30]	208 [8.19]	5 [.20]
Frame M **(300A – 400A)**	160 [6.30]	180 [7.09]	130 [5.12]	25 [.98]	48 [1.89]	200 [7.87]	184 [7.24]	209 [8.23]	180 [7.09]	216 [8.50]	6 [.24]
Frame M **(500A – 580A)**	160 [6.30]	180 [7.09]	130 [5.12]	38 [1.50]	57 [2.24]	200 [7.87]	189 [7.44]	219 [8.62]	180 [7.09]	216 [8.50]	6 [.24]

Figure 34-51. Frame L – M, XTCE185L – XTCE570M Contactors (185 – 580A) — Approximate Dimensions in mm [in]



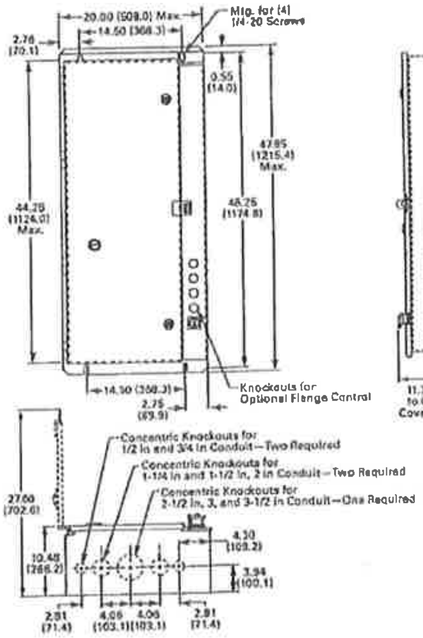
WT = 33 lbs

	W	H	D1	A (Dia.)
XTCE580N	45 [1.77]	296 [11.65]	6 [.24]	13.5 [.53]
XTCE650N	45 [1.77]	296 [11.65]	6 [.24]	13.5 [.53]
XTCE750N	45 [1.77]	296 [11.65]	6 [.24]	13.5 [.53]
XTCE820N	45 [1.77]	296 [11.65]	6 [.24]	13.5 [.53]
XTCEC10N	45 [1.77]	296 [11.65]	10 [.40]	13.5 [.53]

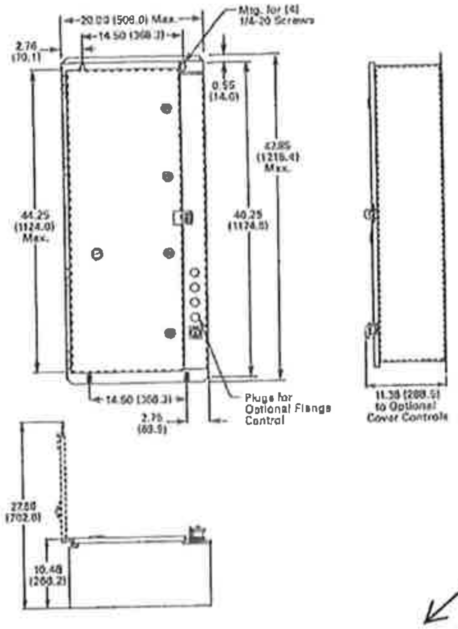
Figure 34-52. Frame N, XTCE580N – XTCEC10N Contactors (580 – 1000A) — Approximate Dimensions in mm [in]

Approximate Dimensions are in Inches (mm)

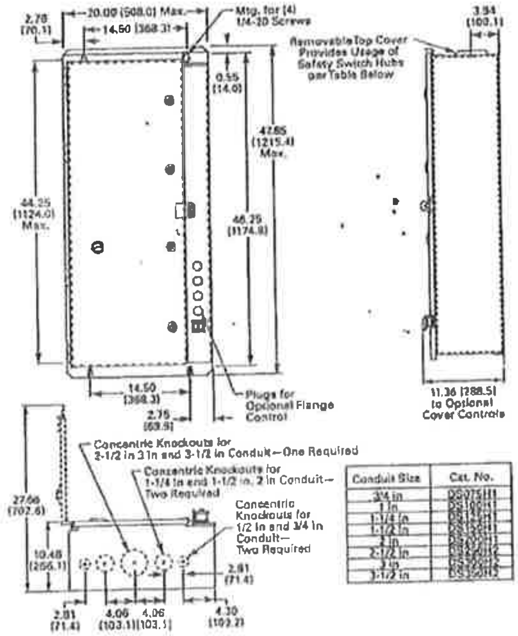
Box 10, Type 1—20.00W x 47.85H x 10.48D



Box 10, Type 12—20.00W x 47.85H x 10.48D

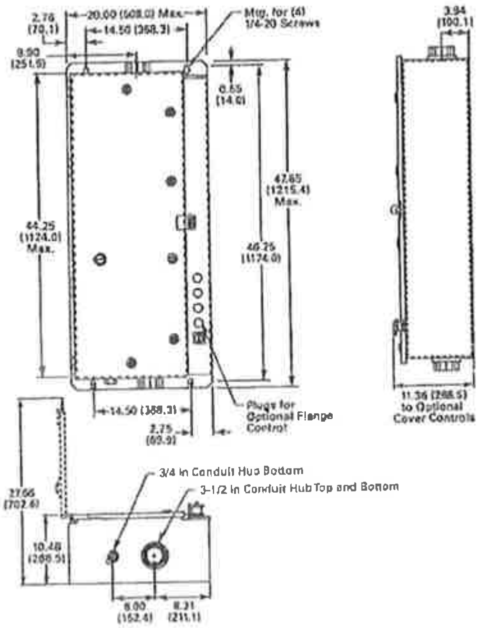


Box 10, Type 3R—20.00W x 47.85H x 10.48D



Conduit Size	Cat. No.
3/4 in	DS075H1
1 in	DS100H1
1-1/4 in	[illegible]
1-1/2 in	[illegible]
2 in	[illegible]
2-1/2 in	[illegible]
3 in	[illegible]
3-1/2 in	[illegible]

Box 10, Type 4X—20.00W x 47.85H x 10.48D



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The 'MITIGATOR' - Next Generation Seismic Sensor.

"Ideal for critical applications where accidental activation cannot be tolerated".

Extremely reliable, compact and maintenance free, the Mitigator Seismic Sensor offers many user-friendly and practical features including: default configurations for nominated seismic standards stored in non-volatile memory, automatic self-test at power-up, and the capture of peak ground acceleration (PGA) values for post-event review.

Inside the 3"X 4" X 0.75" case is a user-programmable switch ideal for industrial earthquake hazard mitigation and shutdown systems. The Mitigator's digital band-pass filter attenuates industrial vibrations and will respond only to the lower frequencies associated with strong seismic events (no false signals). Detects acceleration along three axes; vertical, longitudinal and transverse (P & S waves). Activation setpoints may be re-called from stored factory set-ups (i.e. ASCE 25-97, ASME A17.1, CA3137) or specified by the user via a simple RS-232C connection using the ESS supplied software.

Unique Features:

- **Compliance with ASCE 25-97 and all nominated seismic standards is achieved with this intelligent and flexible, state-of-the-art technology.**
- **Sensor setpoint infinitely user –adjustable from 0.025 g to 1.0 g.**
- **Maintenance free, solid state tri-axial accelerometer – X, Y & Z axes.**
- **Captures local shaking intensity values in 'g'- critical for post-earthquake system performance evaluation.**
- **Operating temperature range, -25°C to 70°C.**
- **Unique filter system and user-adjustable setpoints precludes false activation from industrial vibrations, heavy trucks etc. (no false signals).**
- **Self diagnostics at 'Power-on' and 'Reset'.**

The digital, solid state Mitigator sensor is installed in the ESS Saturn and Apollo Seismic Switches and the MSC valve control systems.

When Earthquakes Strike .... Trust ESS ....

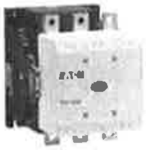
EATON | **Cutler-Hammer**

Application of Electronic Coils, *XT* IEC Contactors from 185A to 2000A

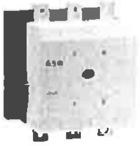
Application Note

New Information
February 2008

Frame L

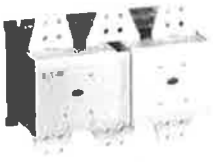


Frame M



Frame N

Frame P



Frame R

Introduction

The Frame L-R XTCE contactors (XTCE185L to XTCEC20R) have a unique coil design giving customers more options when designing their control scheme in a control panel. The electronic coil in the XTCE allows for more control design flexibility, increased safety of design, reduced panel space requirements and panel costs, reduced installation effort, and reduced energy consumption.

Design Flexibility and Increased Safety

The ***XT*** contactor with electronic coil offers a variety of control schemes to provide flexibility in control design. The ***XT*** contactor with electronic coil can be controlled directly from a PLC, an LCCD (low-consumption command device), or by using a traditional control scheme. Through direct control from a PLC or an LCCD, it is possible to eliminate the need for a control power transformer and an interposing relay, which simplifies the overall design. See **Table 1** for the wiring schematics for the various control options of the ***XT*** contactor with electronic coil. Note that the safety/emergency stop connection is located in the A1 – A2 terminal line. This is done to ensure power is removed from the contactor coil if the safety/emergency stop is activated.

In addition to flexible control wiring options, the XTCE electronic coil also provides the ability to enhance control panel safety through the use of low voltage control for large contactor applications. Traditionally, low voltage, such as 24V DC, could not be used to control a large contactor because a large amount of current is required to pull in the contacts on a standard coil design. For example, suppose the power consumption to close a 400 amp contactor with a standard coil design is 850W.

$W = V \times I_{\text{pick-up}}$

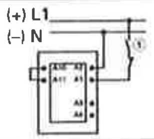
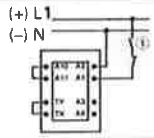
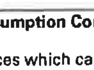
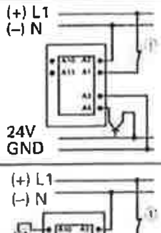
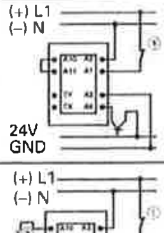
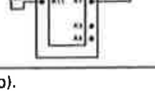
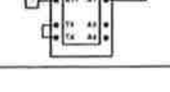
$850W = 24V \times I_{\text{pick-up}}$

$I_{\text{pick-up}} = 850W/24V$

$I_{\text{pick-up}} = 35.4A$

High amperage in the control circuit creates issues in the control design, such as dealing with larger gauge wire and the introduction of other control components, such as an interposing relay. For this reason, many panels with large contactors use a higher control voltage or a dual control voltage, instead of a more safe low voltage design. The electronic coil on the ***XT*** contactor allows users to design their panel with low voltage control and no interposing relays.

Table 1. XTCE Contactors Frame L – R Control Options

Description	XTCE185L – XTCEC14P	XTCEC16R, XTCEC20R
Conventional A1/A2 are applied to voltage in the usual manner.		
Direct from the PLC A 24V output from the PLC can be connected directly to connections A3/A4. 		
From Low-Consumption Command Devices Command devices which can only be subject to minimal loads such as circuit board relays, control circuit devices or position switches can be connected directly to A10/A11.		

① Standstill in an emergency (Emergency Stop).
② Command-device connection.

Application of Electronic Coils, *XT* IEC Contactors from 185A to 2000A

Reduced Panel Space and Installation Effort

When wiring the *XT* contactor for direct control by a PLC or LCCD, the coil can be powered directly from the power circuit instead of the control circuit. This means a control power transformer is no longer needed to power the coil. Removal of a control power transformer from the control design clears space in the panel, and may permit use of a smaller, less expensive panel. No control power transformer also means no associated wiring, translating into faster control panel manufacturing and less chance of a wiring mistake. **Table 2** compares the XTCE with typical power consumption of a standard contactor and the size of a typical control power transformer needed to power coil.

Additionally, the electronic coil design allows for a compact coil design, which in part makes the XTCE contactor smaller in size.

Reduced Energy Consumption

As a general rule, the mass of a contactor is a function of the contactor capacity. And as the contactor mass increases, more energy is required to pull in the contactor. Conventional coil designs are not exempt from this rule. However, as shown in **Table 2**, the XTCE contactor with electronic coil requires significantly less energy to operate compared to a contactor with a conventional coil design. For example, compare power requirements of a standard coil design and the *XT* electronic coil at 120V AC for a 300 amp AC-3 rated contactor:

Typical Pick-Up VA for a standard coil design (300A contactor) = 1100

1100 VA = 120V x $I_{\text{pick-up}}$

$I_{\text{pick-up}}$ = 1100 VA /120V

$I_{\text{pick-up}}$ = 9.17A

XTCE400M Pick-Up VA = 250

250 VA = 120V x $I_{\text{pick-up}}$

$I_{\text{pick-up}}$ = 250 VA /120V

$I_{\text{pick-up}}$ = 2.08A

Typical Sealing VA for a standard coil design (300A contactor) = 35

35 VA = 120V x I_{sealing}

I_{sealing} = 35 VA / 120V

I_{sealing} = 292 mA

XTCE400M Sealing VA = 4.3

4.3 VA = 120V x I_{sealing}

I_{sealing} = 4.3 VA /120V

I_{sealing} = 36 mA

In this example, the *XT* electronic coil requires 1/4 of the power to engage the contacts and 1/8 of the power to maintain contact closure.

Table 2. Typical Consumption of a Non-electronic Coil and the XTCE and Size of Typical Control Power Transformer (CPT) Needed to Power the Coil ①

Contactor Size (AC-3)	**180**	**250**	**300**	**400**	**500**	**650**	**750**	**820**	**1000**
Typical Pick-Up VA	785	1100	1100	980	975	1360	1450	1450	2200
Typical Sealing VA	50	35	35	15	15	20	20	20	25
CPT Height (in)	4-3/4	5-3/4	5-3/4	5-3/4	5-3/4	6-1/2	6-1/2	6-1/2	7-1/2
CPT Width (in)	5-1/4	6-3/4	6-3/4	6-3/4	6-3/4	7-1/2	7-1/2	7-1/2	9
CPT Depth (in)	7	7	7	7	7	7-1/2	7-1/2	7-1/2	7-3/4
XT Contactors	**XTCE 185L**	**XTCE 250L**	**XTCE 300M**	**XTCE 400M**	**XTCE 500M**	**XTCE 650N**	**XTCE 750N**	**XTCE 820N**	**XTCE C10N**
Pick-Up VA	250	250	250	250	250	800	800	800	800
Sealing VA	4.3	4.3	4.3	4.3	4.3	7.5	7.5	7.5	7.5
CPT Height (in)	Not Required When Using Direct Control from PLC or LCCD								
CPT Width (in)									
CPT Depth (in)									

① Typical power consumption values are derived using data from competitive products with conventional coil designs.

Conclusion

The Frame L-R XTCE contactors (XTCE185L to XTCEC20R) provide the flexibility to allow users to design their control panels with optimal safety while minimizing material, manufacturing and energy costs.

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Electrical Group
1000 Cherrington Parkway
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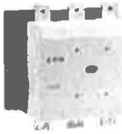
EATON | Cutler-Hammer

Non-reversing Contactors

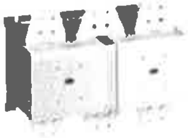
Frame L

Frame M



Frame N

Frame P



Frame R

Table 34-50. Full Voltage Non-reversing 3-Pole Contactors, Frame L – Frame R

UL/CSA Ratings					IEC Ratings							Aux. Contacts	Catalog Number ①	Price U.S. $	
					AC-3 I_e (A)	AC-1 (40°C) $I_e = I_{th}$ (A)	Maximum kW Ratings AC-3								
UL General Purpose Amp Rating	3-Phase hp Ratings						3-Phase Motors 50 – 60 Hz							AC Coil	DC Coil
	200V	230V	460V	575V			220/ 230V	380/ 400V	415V	660/ 690V ②	1000V ②				
Frame L — Standard Coil (110/120V, 230/240V AC Coil Only)															
225	50	60	125	150	185	337	55	90	110	175	108	2NO-2NC	XTCS185L22_		
250	60	75	150	200	225	386	70	110	132	215	108	2NO-2NC	XTCS225L22_		
300	75	100	200	250	250	429	75	132	148	240	108	2NO-2NC	XTCS250L22_		
Frame L — Electronic Coil															
225	50	60	125	150	185	337	55	90	110	175	108	2NO-2NC	XTCE185L22_		
250	60	75	150	200	225	386	70	110	132	215	108	2NO-2NC	XTCE225L22_		
300	75	100	200	250	250	429	75	132	148	240	108	2NO-2NC	XTCE250L22_		
Frame M — Standard Coil (110/120V, 230/240V AC Coil Only)															
350	100	125	250	300	300	490	90	160	180	286	132	2NO-2NC	XTCS300M22_		
450	125	150	300	400	400	612	125	200	240	344	132	2NO-2NC	XTCS400M22_		
550	150	200	400	500	500	857	155	250	300	344	132	2NO-2NC	XTCS500M22_		
550	150	200	400	500	580	980	155	315	350	344	132	2NO-2NC	XTCS570M22_		
Frame M — Electronic Coil															
350	100	125	250	300	300	490	90	160	180	286	132	2NO-2NC	XTCE300M22_		
450	125	150	300	400	400	612	125	200	240	344	132	2NO-2NC	XTCE400M22_		
550	150	200	400	500	500	857	155	250	300	344	132	2NO-2NC	XTCE500M22_		
550	150	200	400	500	580	980	155	315	350	344	132	2NO-2NC	XTCE570M22_		
Frame N — Electronic Coil															
630	200	200	400	600	580	980	185	315	348	560	600	2NO-2NC	XTCE580N22_ ③		
700	200	250	500	600	650	1041	205	355	390	630	600	2NO-2NC	XTCE650N22_ ③		
800	250	300	600	700	750	1102	240	400	455	720	800	2NO-2NC	XTCE750N22_ ③		
850	290	350	700	860	820	1225	260	450	500	750	800	2NO-2NC	XTCE820N22_ ③		
1100	350	420	850	980	1000	1225	315	560	610	1000	1000	2NO-2NC	XTCEC10N22_ ③		
Frame P — Electronic Coil															
1400	—	—	—	—	—	1714	—	—	—	—	—	2NO-2NC	XTCEC14P22_ ③		
Frame R — Electronic Coil															
1600	560	640	1200	1300	1600	2200	500	900	900	1600	1700	2NO-2NC	XTCEC16R22_ ③		
2000	—	—	—	—	—	2450	—	—	—	—	—	2NO-2NC	XTCEC20R22_ ③		

① Underscore (_) indicates magnet coil suffix required. See **Table 34-58, Page 34-38**. Terminals not included. See **Page 34-59** for terminal accessories.

② For 185 – 500A Contactors at 660/690V or 1000V: Do not reverse directly.

③ When operating the 580 – 2000A XTCE contactors with frequency inverters, the suppressor on the load side must be removed. The load side suppressor must also be removed when performing a high-voltage test — see Pub51204, Pub51209.

Table 34-51. Contactor Application Data ④

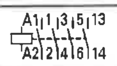
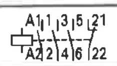
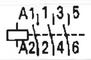
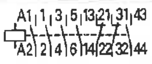
Catalog Prefix	Electrical Life (Operations) for 10hp, 480V (14.2A) Applications
XTCE012B	1 million
XTCE015B	1.2 million
XTCE018C	2 million

④ See **Page 34-88** for Electrical Life Curves.

Note:

AC and DC operated contactors have a built-in suppressor circuit (Frames L – R, 185 – 2000A).

Table 34-52. Full Voltage Non-reversing 3-Pole Contactors — Contact Sequence (Circuit Symbols) — Standard Offering

Contactor Frame	Auxiliary Contacts	Contact Sequence
B – C	1NO	
B – C	1NC	
D – G	—	
L – R	2NO-2NC	

Coil Voltage Chart .... **Page 34-38**
Accessories .... **Page 34-49**
Dimensions .... **Page 34-91**
Overload Relays .... **Page 34-104**
Discount Symbol **1CD7**

Frame N – R

Table 34-111. *XT* Contactors Technical Data and Specifications — Frame N – R

Description	XTCE580N	XTCE650N	XTCE750N, XTCE820N	XTCEC10N	XTCEC14P	XTCEC16R, XTCEC20R
General						
Standards	IEC/EN 60947, VDE 0660, UL, CSA					
Weights in kg [Lb]	15 [33]	15 [33]	15 [33]	15 [33]	15, [33]	32 [70]
Mechanical Life	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Mechanical Operating Frequency (ops/hr)						
AC operated	1000	1000	1000	1000	1000	1000
DC operated	1000	1000	1000	1000	1000	1000
Maximum Operating frequency (ops/hr)	See **Figure 34-45** on **Page 34-90**.					
Climatic Proofing	Damp heat, constant, to IEC 60068-2-78; Damp heat, cyclic, to IEC 60 068-2-30					
Insulation Voltage (Ui) V AC	1000	1000	1000	1000	1000	1000
Impulse Withstand Voltage (Uimp) V AC	8000	8000	8000	8000	8000	8000
Operating Voltage (Ue) V AC	1000	1000	1000	1000	1000	1000
Safe Isolation to VDE 0106 Part 101 and Part 101/A1						
Between coil and contacts (V AC)	500	500	500	500	500	500
Between contacts (V AC)	500	500	500	500	500	500
Making Capacity (Amps)	7800	7800	9840	9840	9840	19000, 9840
Breaking Capacity (Amps)						
220/230V	6500	6500	8200	8200	8200	16000, 8200
380/400V	6500	6500	8200	8200	8200	16000, 8200
500V	6500	6500	8200	8200	8200	16000, 8200
660/690V	6500	6500	8200	8200	8200	16000, 8200
1000V	4350	4350	5800	5800	5800	5800
Short-Circuit Protection Rating Maximum Fuse						
Type 2 Coordination ②						
400V; gG/gL 500V	630	630	630	630	—	—
690V; gG/gL 690V	630	630	630	630	—	—
1000V; gG/gL 1000V	500	500	630	630	—	—
Type 1 Coordination ②						
400V; gG/gL 500V	1000	1000	1200	1200	—	—
690V; gG/gL 690V	1000	1000	1200	1200	—	—
1000V; gG/gL 1000V	630	630	800	800	—	—
Degree of Protection	IP00					
Protection Against Direct Contact when Actuated from Front (Iec 536)	Finger- and back-of-hand proof with terminal shroud or terminal block.					
Main Cable Cross-Section						
Flexible with cable lug (mm^2)	50-240	50-240	50-240	50-240	50-240	50-240
Stranded with cable lug (mm^2)	70-240	70-240	70-240	70-240	70-240	70-240
Solid or Stranded (AWG)	2/0 – 500 MCM	2/0 – 500 MCM	2/0 – 500 MCM	2/0 – 500 MCM	2/0 – 500 MCM	2/0 – 500 MCM
Flat Conductor (mm)	①	①	①	①	①	①
Busbar — Width in mm	50	50	50	50	50	50
Main Cable Connection Screw/Bolt	M10	M10	M12	M12	M12	M12
Tightening torque						
Nm	24	24	35	35	35	35
Lb-in	213	213	311	311	311	311
Control Circuit Cable Cross-Sections						
Solid (mm^2)	1 x (0.75 – 2.5) 2 x (0.75 – 2.5)	1 x (0.75 – 2.5) 2 x (0.75 – 2.5)	1 x (0.75 – 2.5) 2 x (0.75 – 2.5)	1 x (0.75 – 2.5) 2 x (0.75 – 2.5)	1 x (0.75 – 2.5) 2 x (0.75 – 2.5)	1 x (0.75 – 2.5) 2 x (0.75 – 2.5)
Flexible with ferrule (mm^2)	1 x (0.75 – 2.5) 2 x (0.75 – 2.5)	1 x (0.75 – 2.5) 2 x (0.75 – 2.5)	1 x (0.75 – 2.5) 2 x (0.75 – 2.5)	1 x (0.75 – 2.5) 2 x (0.75 – 2.5)	1 x (0.75 – 2.5) 2 x (0.75 – 2.5)	1 x (0.75 – 2.5) 2 x (0.75 – 2.5)
Solid or Stranded (AWG)	2 x (18 – 12)	2 x (18 – 12)	2 x (18 – 12)	2 x (18 – 12)	2 x (18 – 12)	2 x (18 – 12)
Control Circuit Cable Connection Screw/Bolt	M3.5	M3.5	M3.5	M3.5	M3.5	M3.5
Tightening torque						
Nm	1.2	1.2	1.2	1.2	1.2	1.2
Lb-in	10.6	10.6	10.6	10.6	10.6	10.6

① Screw tightening with flat cable terminal or cable terminal blocks. See terminal capacity for cable terminal blocks.

② IEC 60947 Standard.

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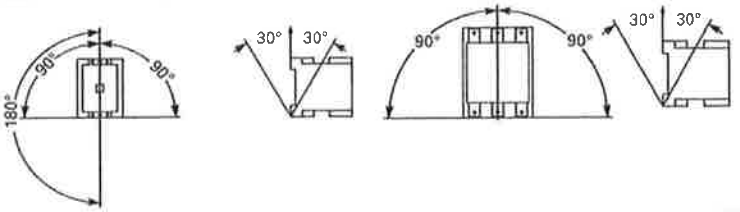
Table 34-111. *XT* Contactors Technical Data and Specifications — Frame N – R (Continued)

Description	XTCE580N	XTCE650N	XTCE750N, XTCE820N	XTCEC10N	XTCEC14P	XTCEC16R, XTCEC20R
General (Continued)						
Tools Main cable wrench Control circuit cable pozidriv screwdriver	 16 mm Size 2	 16 mm Size 2	 18 mm Size 2	 18 mm Size 2	 18 mm Size 2	 18 mm Size 2
Mounting Position, AC and DC Operated						
Ambient Temperature	-25 to 60°C [-13 to 140°F]	-25 to 60°C [-13 to 140°F]	-25 to 60°C [-13 to 140°F]	-25 to 60°C [-13 to 140°F]	-25 to 60°C [-13 to 140°F]	-25 to 60°C [-13 to 140°F]
Ambient Storage Temperature	-40 to 80°C [-40 to 176°F]	-40 to 80°C [-40 to 176°F]	-40 to 80°C [-40 to 176°F]	-40 to 80°C [-40 to 176°F]	-40 to 80°C [-40 to 176°F]	-40 to 80°C [-40 to 176°F]
Environmental						
Mechanical Shock Resistance (IEC/EN 60068-2-27) Half-sinusoidal shock 10 mS (g) Main contact — NO Contact Auxiliary contact — NO Contact Auxiliary contact — NC Contact	 10 10 8	 10 10 8	 10 10 8	 10 10 8	 10 10 8	 10 10 8
Overvoltage Category/Pollution Degree	III/3	III/3	III/3	III/3	III/3	III/3
Switching Capacity, kVar ① Individual Compensation 230V 400/420/440V 525V 690V	 175 300 400 300	 — — — —	 — — — —	 — — — —	 — — — —	 — — — —

① When using contactors for group compensation, a minimum inductance of approx. 6 uh per capacitor must be available to limit the high inrush current peaks. This corresponds to an air-cored coil with 5 windings and a coil diameter of approximately 140 mm. The conductor cross-section must be selected according to the rated current per phase.

Instructional Leaflets

Table 34-112. Instructional Leaflets

Publication Number	Description
Pub51210	7 – 15A, B Frame XTCE, XTCEC and XTCF Contactors and Accessories (Inside of Packaging)
Pub51211	18 – 32A, C Frame XTCE and XTCEC Contactors and Accessories (Inside of Packaging)
Pub51221	XTOB, D Frame Overload Relays (Inside of Packaging)
Pub51222	XTOB, B – C Frame Overload Relays (Inside of Packaging)
Pub51237	7 – 12A, B Frame XTCE Contactors and Auxiliary Contacts
Pub51232	18 – 32A, C Frame XTCE Contactors and Auxiliary Contacts
Pub51216	40 – 65A, D Frame XTCE Contactors and Auxiliary Contacts
Pub51203	185 – 500A, L – M Frame XTCE Contactors and Auxiliary Contacts
Pub51215	S-Series 185 – 500A, L – M Frame XTCE Contactors and Auxiliary Contacts
Pub51204	580 – 1000A, N Frame XTCE Contactors and Auxiliary Contacts
Pub51209	1400 – 2000A, P – R Frame XTCE Contactors and Auxiliary Contacts
Pub51213	7 – 150A, B – G Frame XTAE Non-reversing and XTAR Reversing Starters
Pub51217	XTCEXFA and XTCEXSA Front and Side Mount Auxiliary Contacts from 40 – 150A, D – G Frame XTCE Contactors
Pub51212	XTCEXML Mechanical Interlock for 7 – 150A, B – G Frame XTCE Contactors
Pub51214	XTCEXRL Reversing Link Kits for 18 – 32A, C Frame XTCE Contactors
Pub51218	XTCEXTL Lug Kits for 500 – 820A, M – N Frame XTCE Contactors
Pub51219	XTCEXRLB and XTCEXSDLB Reversing and Star-Delta (Wye-Delta) Link Kits for 7 – 12A, B Frame XTCE Contactors
Pub51205	Accessories for 185 – 500A, L – M Frame XTCE Contactors
Pub51207	Replacement DC Coils
Pub51213	Renewal Parts — Coils for 18 – 32A, C Frame XTCE Contactors
Pub51186	Renewal Parts — Coils for 40 – 65A, D Frame XTCE Contactors

Table 34-115. Coil Data — Frame L – R (Continued)

Description	XTCE580N	XTCE750N, XTCE820N	XTCEC10N	XTCEC14P	XTCE16R, XTCEC20R
Voltage Tolerance					
Pick-Up (x U_C)					
XTCE185L – XTCEC20R	0.7 x Ucmin — 1.15 x Ucmax				
XTCS185L – XTCS500M	0.85 x Ucmin — 1.1 x Ucmax				
Drop-Out (x U_C)					
XTCE185L – XTCEC20R	0.2 x Ucmin — 0.6 x Ucmax				
XTCS185L – XTCS500M	0.2 x Ucmin — 0.4 x Ucmax				
Power Consumption of the coil at cold state and 1.0 x U_C					
XTCE185L – XTCEC20R					
Pick-Up VA	800 ①	800 ①	800 ①	800 ①	1600 ①
Pick-Up W	700	700	700	700	1400
Sealing VA	7.5	7.5	7.5	7.5	15
Sealing W	6.5	6.5	6.5	6.5	13
XTCS185L — XTCS500M					
Pick-Up VA	—	—	—	—	—
Pick-Up W	—	—	—	—	—
Sealing VA	—	—	—	—	—
Sealing W	—	—	—	—	—
Duty Factor (%DF)	100	100	100	100	100
Switching Time at 100% Main Contact U_C (approximate values)					
XTCE185L – XTCEC20R					
Closing delay (mS)	<70	<70	<70	<70	<70
Opening delay (mS)	<70	<70	<70	<40	<40
XTCS185L – XTCS500M					
Closing delay (mS)	—	—	—	—	—
Opening delay (mS)	—	—	—	—	—
Reaction in Threshold and Sealing State Transition Range (XTCE185L – XTCEC20R)					
Voltage interruptions					
$(0 - 0.2 \times U_{cmin}) \leq 10ms$	Time is bridged successfully				
$(0 - 0.2 \times U_{cmin}) > 10ms$	Drop-out of the contactor				
Voltage Dips					
$(0.2 - 0.6 \times U_{cmin}) \leq 12ms$	Time is bridged successfully				
$(0.2 - 0.6 \times U_{cmin}) > 12ms$	Drop-out of the contactor				
$(0.6 - 0.7 \times U_{cmin})$	Contactor remains switched on				
Excess Voltage					
$(1.15 - 1.3 \times U_{cmax})$	Contactor remains switched on				
$(>1.3 \times U_{cmax}) \leq 3s$	Contactor remains switched on				
$(>1.3 \times U_{cmax}) > 3s$	Drop-out of the contactor				
Pick – Up phase					
$(0 - 0.7 \times U_{cmin})$	Contactor does not switch on				
$(0.7 \times U_{cmin} - 1.15 \times U_{cmax})$	Contactor switches on with certainty				
$(>1.15 \times U_{cmax})$	Contactor switches on with certainty				
Permissible contact resistance (of the external command device with actuation of A11), Ω	≤500	≤500	≤500	≤500	≤500
Permissible residual current (with actuation of A11 by the electronics with 0 signal)	≤1	≤1	≤1	≤1	≤1
SPS Signal Level (A3 – A4) to IEC/EN 61131-2 (Type 2)					
High	15V	15V	15V	15V	15V
Low	5V	5V	5V	5V	5V
Electromagnetic compatibility (EMC)	This product is designed for operation in industrial environments. Usage in domestic areas can cause radio frequency interference (RFI). Noise suppression measures must be provided for the additional interference.				

① Control transformer with $U_k \leq 7\%$.

Auxiliary Contacts

Table 34-117. Auxiliary Contacts Technical Data and Specifications

Description	XTCE007B...– XTCE032C	XTCEXFAC... XTCEXFATC...	XTCEXFCC... XTCEXSCC...	XTCEXFAG...	XTCEXSBLN... XTCEXSBN... XTCEXSBNC... XTCEXSCN... XTCEXSCNC...
Interlocked opposing contacts with an auxiliary contact module (to IEC 60947-5 -1 Annex L)	—	Yes	Yes	Yes	Yes
Break contact (not late-break contact) suitable as a mirror contact (to IEC/EN 60947-4 -1 Annex F)	XTCE007B... – XTCE032C	XTCE007B... – XTCE032C	XTCE007B... – XTCE032C	XTCE040D... – XTCE065D...	XTCE040D... – XTCE065D... XTCE185L... – XTCEC10N...
Rated impulse withstand voltage, (Uimp) V AC	6000	6000	6000	6000	6000
Overvoltage category / pollution degree	III/3	III/3	III/3	III/3	III/3
Rated insulation voltage, (Ui) V AC	690	690	690	690	690
Rated operational voltage, (U_e) V AC	500	500	500	500	500
Safe isolation to VDE 0106 Part 101 and Part 101(A) in V AC					
Between coil and auxiliary contacts	400	400	400	440	440
Between the auxiliary contacts	400	400	400	440	440
Rated Operational Current, I_e					
AC-15					
230V	6A	6A	6A	6A	6A
380/415V	4A	3A	4A	4A	4A
500V	1.5A	—	1.5A	1.5A	1.5A
DC-3 L/R ≤5 mS ①					
24V	10A	10A	10A	10A	10A
60V	6A	6A	6A	6A	6A
110V	3A	3A	3A	3A	3A
220V	1A	1A	1A	1A	1A
Conventional thermal current, I_{th}	16A	16A	16A ③	10A	10A
Control circuit reliability (at U_e = 24 V DC, U_{min} = 17 V, I_{min} = 5.4 mA)	$<10^{-8}$, < one failure at 100 million operations				
Component Lifespan, Operations x 10^6 at U_e = 230V, AC-15, 3A	1.3	1.3	1.3	1.3	1.3
Short-circuit rating without welding ② Maximum fuse, gG/gL	10A	10A	10A	16A	16A

① Making and breaking conditions to DC-13, time L/R contact as stated.

② See fuses overlay for time/current characteristic (on request).

③ Conventional thermal current (I_{th}) of XTCEXSCC_ is 10A.

Table 34-118. Parallel Link Technical Data and Specifications

Description	XTCEXPLKB	XTECXPLKC	XTCEXPLKD	XTCEXPLKG	XTCEXPLK185
Terminal Capacity					
Solid (mm^2)	1 – 16	16	16	—	—
Flexible with ferrule (mm^2)	1 x (0.5 – 25) 2 x (0.5 – 16)	1 x (16 – 35)	1 x (16 – 120)	—	—
Stranded (mm^2)	1 x (0.5 – 25) 2 x (0.5 – 16)	1 x (16 – 50)	1 x (16 – 120)	1 x (35 – 300) 2 x (35 – 120)	—
Flat conductor — number of segments x width x thickness (mm)	6 x 9 x 0.8	—	—	2 x (11 x 21 x 1)	1 x (6 x 16 x 0.8) 2 x (20 x 32 x 0.5) 2 x (11 x 21 x 1)
Tightening Torque (Nm)	4	4	14	—	—
Tools					
Pozidriv screwdriver	Size 2	Size 2	—	—	—
Hexagon socket head spanner — SW (mm)	—	—	5	6	—
Conventional Thermal Current					
3-Pole (I_{th}) A	50	100	180	400	—
4-Pole (I_{th}) A	60	—	—	—	—

Table 34-119. Cable Terminal Block, Flat Cable Terminal Technical Data and Specifications

Description	XTCEXTLA400	XTCEXPLK185	XTCEXTFB650	XTCEXTFB820
Terminal Capacity				
Stranded (mm^2)	1 x (120 – 300) 2 x (70 – 240)	—	—	—
Stranded (AWG)	1 x (1/0 – 600 MCM) 2 x (1/0 – 500 MCM)	—	—	—
Flat conductor — number of segments x width x thickness (mm)	1 x (10 x 16 x 0.8) 2 x (20 x 24 x 0.5) 2 x (11 x 21 x 1)	1 x (6 x 16 x 0.8) 2 x (20 x 32 x 0.5) 2 x (11 x 21 x 1)	1 x (6 x 16 x 0.8) 2 x (20 x 32 x 0.5) 2 x (11 x 21 x 1)	1 x (6 x 16 x 0.8) 2 x (10 x 40 x 1) 2 x (20 x 40 x 0.5)

Table 34-120. AC Ratings (Continued)

Description	XTCE650N	XTCE750N	XTCE820N	XTCEC10N	XTCEC14P	XTCEC16R	XTCEC20R
AC-1 Operation							
Conventional Free Air Thermal Current, 3-Pole, 50 – 60 Hz							
at 40°C (I_{th})	1041	1102	1225	1225	1714 ①	2200	2450 ①
at 50°C (I_{th})	931	986	1095	1095	1533 ①	1970	2190 ①
at 55°C (I_{th})	888	940	1044	1044	1462 ①	1800	2089 ①
at 60°C (I_{th})	850	900	1000	1000	1400 ①	1800	2000 ①
Conventional Free Air Thermal Current, 1-Pole (I_{th})	2125	2250	2500	2500	3500	4500	5000
AC-3 Operation							
Rated Operational Current, 50/60 Hz ② (I_e) in amperes							
220/230V	650	750	820	1000	—	1600	—
240V	650	750	820	1000	—	1600	—
380/400V	650	750	820	1000	—	1600	—
415V	650	750	820	1000	—	1600	—
440V	650	750	820	1000	—	1600	—
500V	650	750	820	1000	—	1600	—
660/690V	650	750	820	1000	—	1600	—
1000V	435	580	580	700	—	—	—
Rated power (P) in kilowatts							
220/230V	205	240	260	315	—	500	—
240V	225	260	285	340	—	550	—
380/400V	355	400	450	560	—	900	—
415V	390	455	500	610	—	930	—
440V	420	480	525	650	—	1000	—
500V	470	550	600	730	—	1180	—
660/690V	630	720	750	1000	—	1600	—
1000V	600	800	800	1000	—	—	—
AC-4 Operation							
Rated Operational Current, 50/60 Hz ② (I_e) in amperes							
220/230V	512	576	656	800	—	1280	—
240V	512	576	656	800	—	1280	—
380/400V	512	576	656	800	—	1280	—
415V	512	576	656	800	—	1280	—
440V	512	576	656	800	—	1280	—
500V	512	576	656	800	—	1280	—
660/690V	512	576	656	800	—	1280	—
1000V	348	464	464	700	—	—	—
Rated power (P) in kilowatts							
220/230V	161	181	209	260	—	430	—
240V	176	200	228	280	—	450	—
380/400V	280	315	355	450	—	750	—
415V	307	346	394	490	—	770	—
440V	326	367	418	520	—	830	—
500V	370	417	474	590	—	940	—
660/690V	494	556	633	780	—	1300	—
1000V	509	678	678	1000	—	—	—
AC-6A Operation							
Transformer Loads	Values are application specific. Calculation is $I_{eAC\text{-}3} = X / 6 * I_e$ Transformer where X is the inrush current of the transformer and I_e Transformer is the nominal current. ③						
AC-6B Operation							
Capacitor Loads Individual compensation rated operational current I_e of three-phase capacitors in amperes							
Up to 525V	463	463	463	463	—	—	—
690V	265	265	265	265	—	—	—
Maximum inrush current peak (x I_e)	30	30	30	30	—	—	—
Component Lifesaving (Operations)	100,000	100,000	100,000	100,000	—	—	—
Maximum Operating Frequency (ops/hr)	200	200	200	200	—	—	—

① Up to 690V.

② At maximum permissible ambient temperature.

③ Example —
The transformer has a nominal current of 10A with an inrush current of 18 times the nominal current. So, the contactor must have an AC-3 current of 18/6 x 10A = 30A. Using an XTCE032C (32A AC-3) contactor is recommended.

DC Ratings

Table 34-122. DC Ratings — DC-1

Description	XTCE007B	XTCE009B	XTCE012B, XTCF020B	XTCE015B	XTCE018C	XTCE025C	XTCE032C
Rated operation current {1} (I_e) in amperes							
60V	20	20	20	20	35	40	40
110V	20	20	20	20	35	40	40
220V	15	15	15	15	35	40	40
440V	1	1.3	1.3	1.3	2.9	2.9	2.9
	XTCE040D	XTCE050D	XTCE065D	XTCE080F	XTCE095F	XTCE115G	XTCE150G
60V	50	60	72	110	110	160	160
110V	50	50	72	110	110	160	160
220V	45	45	65	70	70	90	90
440V	2.9	2.9	2.9	4.5	4.5	4.5	4.5
	XTCE185L	XTCE225L	XTCE250L	XTCE300M	XTCE400M	XTCE500M	XTCE580N
60V	300	300	300	400	400	400	—
110V	300	300	300	400	400	400	—
220V	300	300	300	400	400	400	—
440V	11	11	11	11	11	11	—
	XTCE650N	XTCE750N	XTCE820N	XTCEC10N	XTCEC14P	XTCEC20R	XTCEC16R
60V	—	—	—	—	—	—	—
110V	—	—	—	—	—	—	—
220V	—	—	—	—	—	—	—
440V	—	—	—	—	—	—	—

Table 34-123. DC Ratings — DC-3

Description	XTCE007B	XTCE009B	XTCE012B	XTCE015B	XTCE018C	XTCE025C	XTCE032C
Rated operation current {1} (I_e) in amperes							
60V	20	20	20	20	35	35	40
110V	20	20	20	20	35	35	40
220V	1.5	1.5	1.5	1.5	10	10	25
440V	0.2	0.2	0.2	0.2	0.6	0.6	0.6
	XTCE040D	XTCE050D	XTCE065D	XTCE080F	XTCE095F	XTCE115G	XTCE150G
60V	50	60	72	110	110	160	160
110V	50	50	72	110	110	160	160
220V	25	25	35	35	35	40	40
440V	0.6	0.6	0.6	1	1	1	1
	XTCE185L	XTCE225L	XTCE250L	XTCE300M	XTCE400M	XTCE500M	XTCE580N
60V	300	300	300	400	400	400	—
110V	300	300	300	400	400	400	—
220V	300	300	300	400	400	400	—
440V	—	—	—	—	—	—	—
	XTCE650N	XTCE750N	XTCE820N	XTCEC10N	XTCEC14P	XTCEC20R	XTCEC16R
60V	—	—	—	—	—	—	—
110V	—	—	—	—	—	—	—
220V	—	—	—	—	—	—	—
440V	—	—	—	—	—	—	—

Table 34-124. DC Ratings — DC-5

Description	XTCE007B	XTCE009B	XTCE012B	XTCE015B	XTCE018C	XTCE025C	XTCE032C
Rated operation current (1) (I_e) in amperes							
60V	20	20	20	20	35	35	40
110V	20	20	20	20	35	35	40
220V	1.5	1.5	1.5	1.5	10	10	25
440V	0.2	0.2	0.2	0.2	0.6	0.6	0.6
	XTCE040D	**XTCE050D**	**XTCE065D**	**XTCE080F**	**XTCE095F**	**XTCE115G**	**XTCE150G**
60V	50	60	72	110	110	160	160
110V	50	50	72	110	110	160	160
220V	25	25	35	35	35	40	40
440V	0.6	0.6	0.6	1	1	1	1
	XTCE185L	**XTCE225L**	**XTCE250L**	**XTCE300M**	**XTCE400M**	**XTCE500M**	**XTCE580N**
60V	300	300	300	400	400	400	—
110V	300	300	300	400	400	400	—
220V	300	300	300	400	400	400	—
440V	—	—	—	—	—	—	—
	XTCE650N	**XTCE750N**	**XTCE820N**	**XTCEC10N**	**XTCEC14P**	**XTCEC20R**	**—**
60V	—	—	—	—	—	—	—
110V	—	—	—	—	—	—	—
220V	—	—	—	—	—	—	—
440V	—	—	—	—	—	—	—

Table 34-125. DC Ratings — 4-Pole

Description	XTCF020B	XTCF032C	XTCF045C	XTCF063D	XTCF080D	XTCF125G	XTCF160G	XTCF200G
Rated operational current, open (I_e) in amperes								
DC-1 Operation								
60V	22	32	45	63	80	125	160	200
110V	22	32	45	63	80	125	160	200
220V	6	32	45	63	80	125	160	200
440V	1.3	3	3	5	5	100	125	150
DC-3 Operation								
60V	20	32	45	63	80	125	160	200
110V	20	32	45	63	80	125	160	200
220V	1.5	32	45	63	80	125	160	200
440V	0.2	6	6	8	8	75	95	115
DC-5 Operation								
60V	20	32	45	63	80	125	160	200
110V	20	25	32	50	80	125	160	200
220V	1.5	15	22	38	70	100	125	150
440V	0.2	4	4	8	8	60	75	90

Heat Loss

Table 34-126. Current Heat Loss (3-Pole) in Watts

Description	XTCE007B	XTCE009B	XTCE012B, XTCF020B	XTCE015B	XTCE018C	XTCE025C	XTCE032C
Current heat loss (3-Pole) in watts							
at I_{th}	3	3	3	3	7.3	9.6	12.1
at I_e to AC-3/400V	0.37	0.6	1.1	1.8	1.9	3.8	6.1
Impedance per pole, mΩ	2.5	2.5	2.5	2.5	2	2	2

	XTCE040D	XTCE050D	XTCE065D	XTCE072D	XTCE080F	XTCE095F	XTCE115G	XTCE150G	XTCE170G
Current heat loss (3-Pole) in watts									
at I_{th}	11.3	19	28.8	28.8	12.2	18.2	20.3	30.7	41.1
at I_e to AC-3/400V	7.2	11.3	19	23	9.6	13.5	15.9	27.0	34.7
Impedance per pole, mΩ	1.5	1.5	1.5	1.5	0.5	0.5	0.4	0.4	0.4

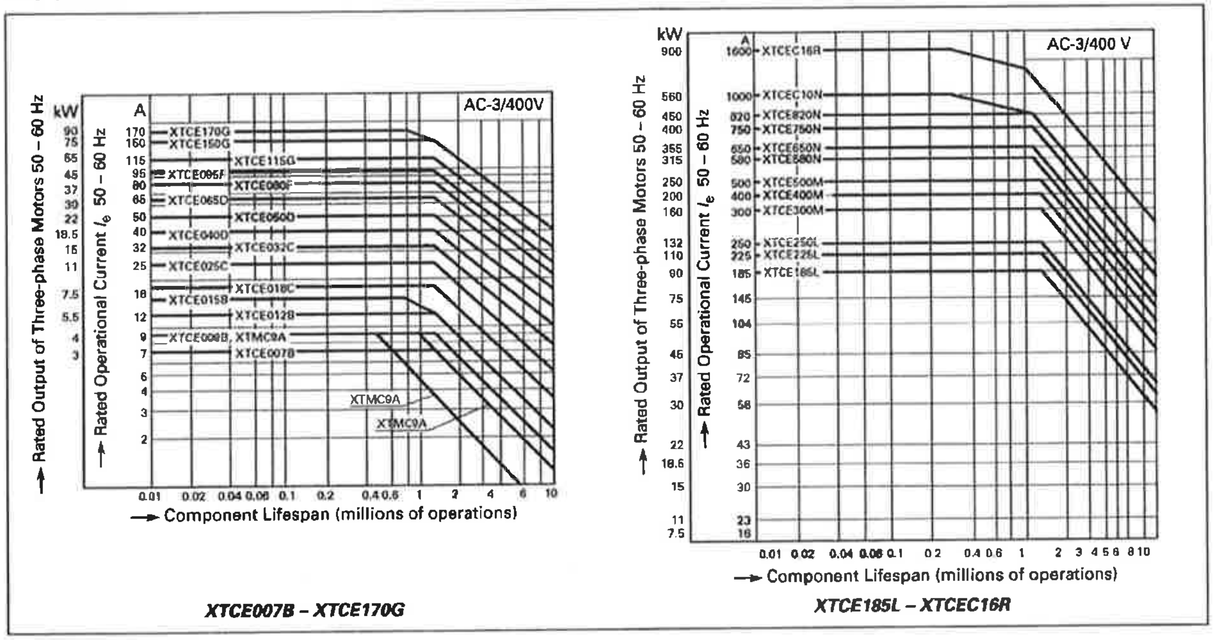
	XTCE185L	XTCE225L	XTCE250L	XTCE300M	XTCE400M	XTCE500M	XTCE580N
Current heat loss (3-Pole) in watts							
at I_{th}	34	45	55	37	58	113	61
at I_e to AC-3/400V	16	23	28	21	37	58	32
Impedance per pole, mΩ	—	—	—	—	—	—	—

	XTCE650N	XTCE750N	XTCE820N	XTCEC10N	XTCEC14P	XTCEC20R	XTCEC16R
Current heat loss (3-Pole) in watts							
at I_{th}	69	78	96	96	188	192	155
at I_e to AC-3/400V	41	54	65	96	—	—	123
Impedance per pole, mΩ	—	—	—	—	—	—	—

Table 34-127. Current Heat Loss (4-Pole) in Watts

Description	XTCF020B	XTCF032C	XTCF045C	XTCF063D	XTCF080D	XTCF125G	XTCF160G	XTCF200G
Current Heat Loss (3-Pole)								
at I_{th} in watts	4.7	8.2	12	16	23	29	46	60
Impedence per pole, mΩ	2.5	2	1.5	1	0.7	0.6	0.6	0.5

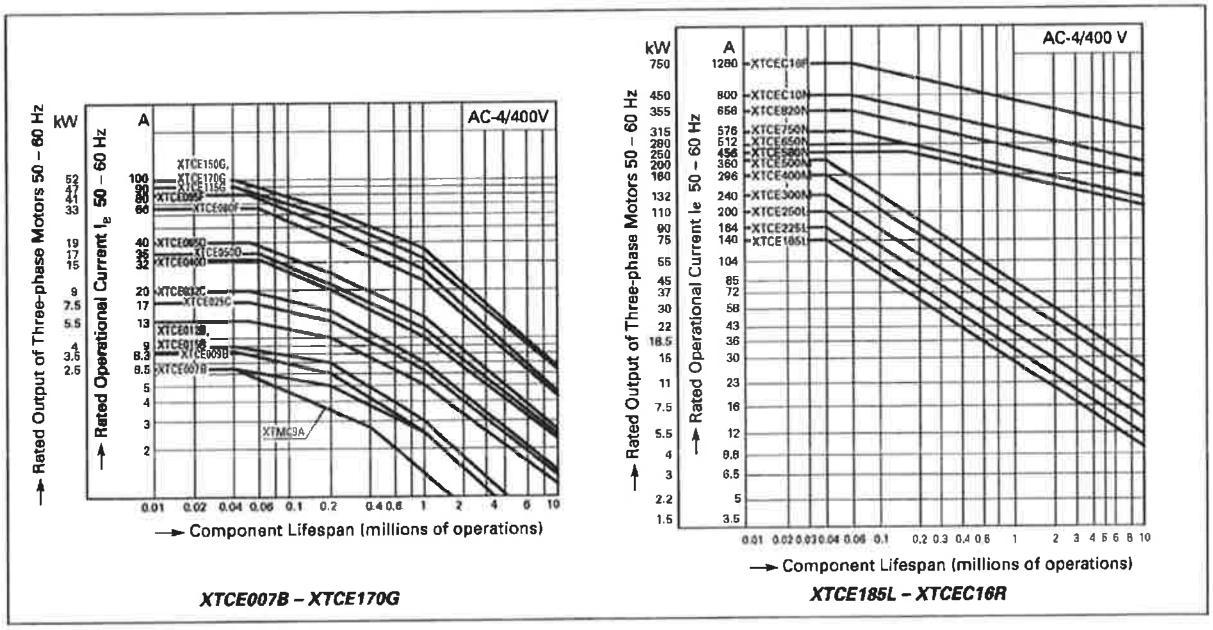
Life Curves



XTCE007B – XTCE170G

XTCE185L – XTCEC16R

Figure 34-39. Normal Switching Duty



XTCE007B – XTCE170G

XTCE185L – XTCEC16R

Figure 34-40. Extreme Switching Duty

Contactors and Starters

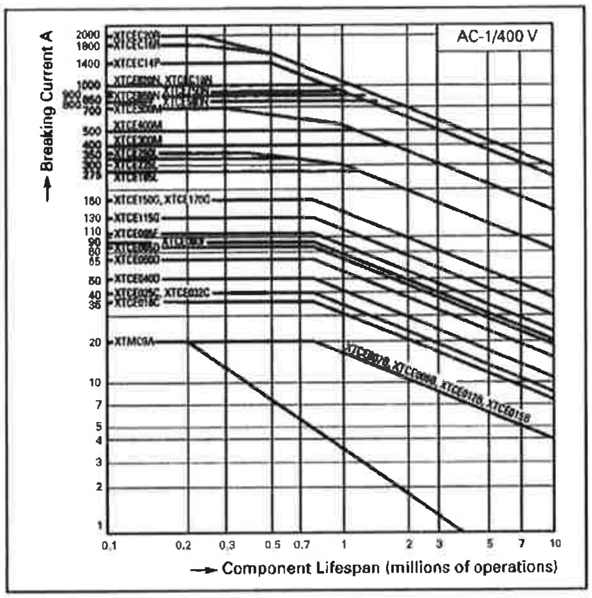


Figure 34-43. Switching Duty for Non-motor Loads, 3-Pole — XTCE007B – XTCEC20R

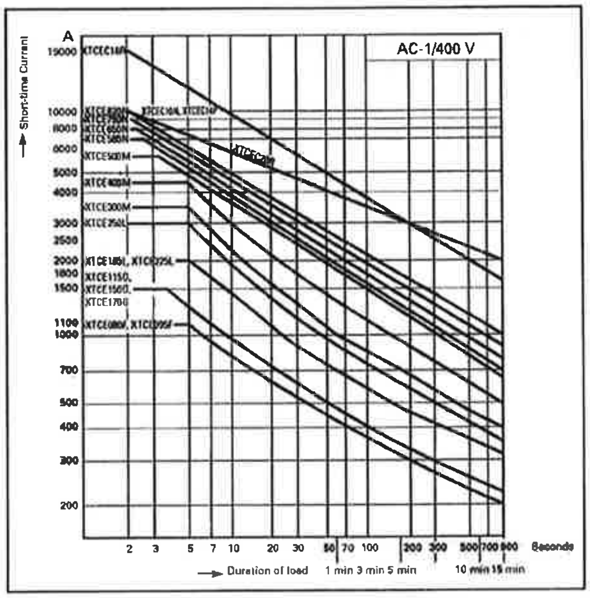
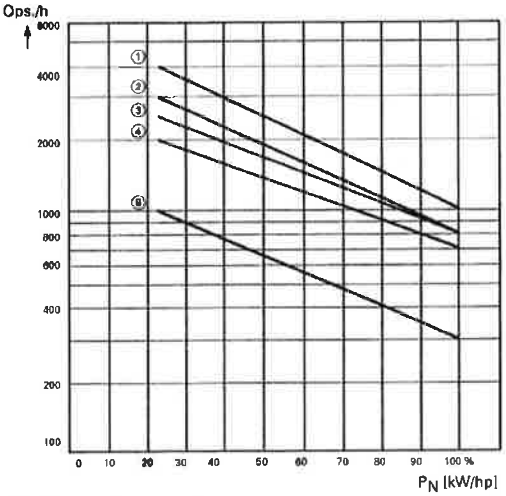


Figure 34-44. Short-Time Loading, 3-Pole — XTCE080F – XTCEC16R

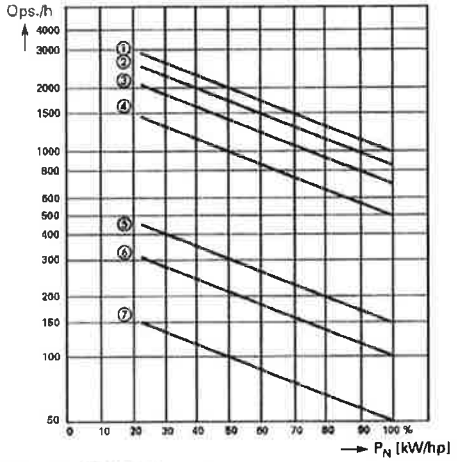


Utilization Category ①

Type	Characteristic Curve Above		
	AC-1	AC-3	AC-2 AC-4
XTCE007B – XTCE015B	3	1	5
XTCE018C – XTCE032C	3	2	5
XTCE040D – XTCE065D	3	2	5
XTCE080F – XTCE150G	3	4	5

① P_N = max. motor rating (kW/hp) of the relevant contactor.
ops./h = max. number of operations per hour.

7 to 150 hp



Utilization Category ④

Type	Characteristic Curve Above		
	AC-1	AC-3	AC-4
XTCE185L XTCE225L XTCE250L	2 2 2	1 1 1	6 6 6
XTCE300M XTCE400M XTCE500M	3 3 3	2 2 2	7 7 7
XTCE580N XTCE650N XTCE750N XTCE820N	3 3 3 3	4 4 4 4	5 5 5 5

④ P_N = max. motor rating (kW/hp) of the relevant contactor.
ops./h = max. number of operations per hour.

185 to 820 hp

Figure 34-45. Maximum Operating Frequency — Related to Rating and Utilization Category (400V)

Hinge Cover

Continuous-Hinge with Clamps, Type 4X

Industry Standards

UL 50, 50E Listed; Type 3R, 4, 4X, 12; File No. E27567
cUL Listed per CSA C22.2 No 94; Type 3R, 4, 4X, 12; File No. E27567
UL 508A Listed; Type 3R, 4, 4X, 12; File No. E61997
cUL Listed per CSA C22.2 No 94; Type 3R, 4, 4X, 12; File No. E61997

NEMA/EEMAC Type 3R, 4, 4X, 12, 13
CSA File No. 42184: Type 4, 4X, 12
IEC 60529, IP66
Meets NEMA Type 3RX requirements

Application

Used in either indoor or outdoor applications, these enclosures combine a rugged continuous hinge, seamless foam-in-place gasket and stainless steel screw-down clamps for a reliable seal that protects components from corrosive environments.

Specifications

- 16 and 14 gauge Type 304 or 316L stainless steel
- Seams continuously welded and ground smooth
- Seamless foam-in-place gasket
- Stainless steel screws and clamps
- Pull stainless steel continuous hinge pin to remove door
- Weldnuts provided for mounting optional panels and terminal block kits
- Bonding provision on door and body

Finish

Cover and sides of body have smooth #4 brushed finish.

Accessories

See also Accessories.
Fast-Operating Clamp-Cover Junction Box Clamp
Lock Kit for Clamp Cover Junction Boxes
Panels for Junction Boxes
Terminal Block Kit Assembly for Junction Boxes Overview

Modification and Customization

Hoffman excels at modifying and customizing products to your specifications. Contact your local Hoffman sales office or distributor for complete information.

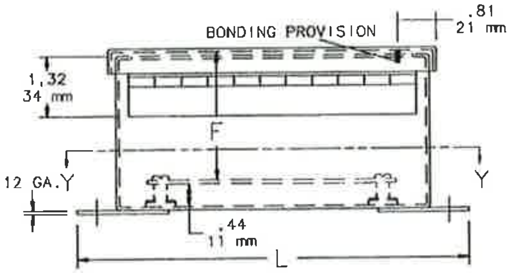
Bulletin: A51S

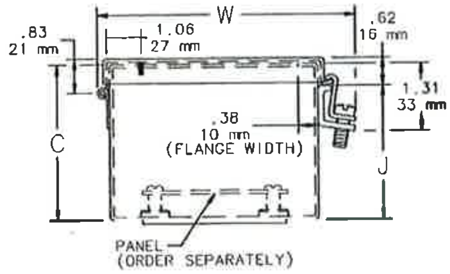
Standard Product

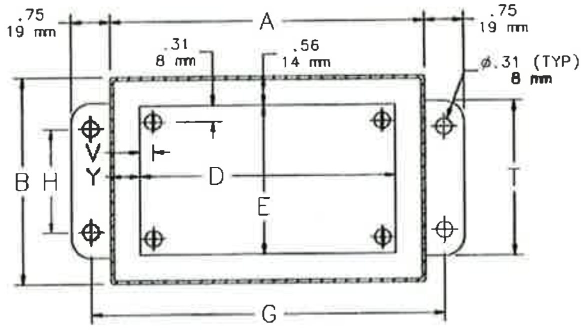
Catalog Number	AxBxC In./mm	Stainless Steel Type	UL Listed	Body Gauge	Cover Gauge	Steel Panel	Conductive Panel	Panel Size D x E In./mm	Mounting G x H In./mm	Overall L x W In./mm	F In./mm	J In./mm	N In./mm	T In./mm	V In./mm	Y In./mm
A6044CHNFSS	6.00 x 4.00 x 4.00 152 x 102 x 102	304	508A	16	16	A6P4	A6P4G	4.88 x 2.88 124 x 73	6.75 x 2.00 171 x 51	7.50 x 4.94 191 x 125	3.50 89	3.62 92	2.38 60	3.00 76	0.31 8	0.56 14
A606CHNFSS	6.00 x 6.00 x 4.00 152 x 152 x 102	304	50, 50E	16	16	A6P6	A6P6G	4.88 x 4.88 124 x 124	6.75 x 4.00 171 x 102	7.50 x 6.94 191 x 176	3.50 89	3.62 92	2.38 60	5.00 127	0.31 8	0.56 14
A8064CHNFSS	8.00 x 6.00 x 4.00 203 x 152 x 102	304	50, 50E	14	16	A8P6	A8P6G	6.75 x 4.88 171 x 124	8.75 x 4.00 222 x 102	9.50 x 6.94 241 x 176	3.50 89	3.62 92	1.38 35	5.00 127	0.25 6	0.62 16
A1008CHNFSS	10.00 x 8.00 x 4.00 254 x 203 x 102	304	50, 50E	14	16	A10P8	A10P8G	8.75 x 6.88 222 x 175	10.75 x 6.00 273 x 152	11.50 x 8.94 292 x 227	3.50 89	3.62 92	1.38 35	7.00 178	0.25 6	0.62 16
A12106CHNFSS	12.00 x 10.00 x 6.00 305 x 254 x 152	304	50, 50E	14	16	A12P10	A12P10G	10.75 x 8.88 273 x 225	12.75 x 8.00 324 x 203	13.50 x 10.94 343 x 278	5.50 140	5.62 143	2.38 60	9.00 229	0.25 6	0.62 16
A1212CHNFSS	12.00 x 12.00 x 6.00 305 x 305 x 152	304	50, 50E	14	16	A12P12	A12P12G	10.75 x 10.88 273 x 276	12.75 x 10.00 324 x 254	13.50 x 12.94 343 x 329	5.50 140	5.62 143	2.38 60	11.00 279	0.25 6	0.62 16
A1412CHNFSS	14.00 x 12.00 x 6.00 356 x 305 x 152	304	50, 50E	14	16	A14P12	A14P12G	12.75 x 10.88 324 x 276	14.75 x 10.00 375 x 254	15.50 x 12.94 394 x 329	5.50 140	5.62 143	2.38 60	11.00 279	0.25 6	0.62 16
A1614CHNFSS	16.00 x 14.00 x 6.00 406 x 356 x 152	304	508A	14	16	A16P14	A16P14G	14.75 x 12.88 375 x 327	16.75 x 12.00 425 x 305	17.50 x 14.94 445 x 379	5.50 140	5.62 143	2.38 60	13.00 330	0.25 6	0.62 16
A6044CHNFSS6	6.00 x 4.00 x 4.00 152 x 102 x 102	316L	50, 50E	16	16	A6P4	A6P4G	4.88 x 2.88 124 x 73	6.75 x 2.00 171 x 51	7.50 x 4.94 191 x 125	3.50 89	3.62 92	2.38 60	3.00 76	0.31 8	0.56 14
A606CHNFSS6	6.00 x 6.00 x 4.00 152 x 152 x 102	316L	50, 50E	16	16	A6P6	A6P6G	4.88 x 4.88 124 x 124	6.75 x 4.00 171 x 102	7.50 x 6.94 191 x 176	3.50 89	3.62 92	2.38 60	5.00 127	0.31 8	0.56 14
A8064CHNFSS6	8.00 x 6.00 x 4.00 203 x 152 x 102	316L	50, 50E	14	16	A8P6	A8P6G	6.75 x 4.88 171 x 124	8.75 x 4.00 222 x 102	9.50 x 6.94 241 x 176	3.50 89	3.62 92	1.38 35	5.00 127	0.25 6	0.62 16
A1008CHNFSS6	10.00 x 8.00 x 4.00 254 x 203 x 102	316L	50, 50E	14	16	A10P8	A10P8G	8.75 x 6.88 222 x 175	10.75 x 6.00 273 x 152	11.50 x 8.94 292 x 227	3.50 89	3.62 92	1.38 35	7.00 178	0.25 6	0.62 16
A12106CHNFSS6	12.00 x 10.00 x 6.00 305 x 254 x 152	316L	50, 50E	14	16	A12P10	A12P10G	10.75 x 8.88 273 x 225	12.75 x 8.00 324 x 203	13.50 x 10.94 343 x 278	5.50 140	5.62 143	2.38 60	9.00 229	0.25 6	0.62 16
A1212CHNFSS6	12.00 x 12.00 x 6.00 305 x 305 x 152	316L	50, 50E	14	16	A12P12	A12P12G	10.75 x 10.88 273 x 276	12.75 x 10.00 324 x 254	13.50 x 12.94 343 x 329	5.50 140	5.62 143	2.38 60	11.00 279	0.25 6	0.62 16
A1412CHNFSS6	14.00 x 12.00 x 6.00 356 x 305 x 152	316L	50, 50E	14	16	A14P12	A14P12G	12.75 x 10.88 324 x 276	14.75 x 10.00 375 x 254	15.50 x 12.94 394 x 329	5.50 140	5.62 143	2.38 60	11.00 279	0.25 6	0.62 16
A1614CHNFSS6	16.00 x 14.00 x 6.00 406 x 356 x 152	316L	50, 50E	14	16	A16P14	A16P14G	14.75 x 12.88 375 x 327	16.75 x 12.00 425 x 305	17.50 x 14.94 445 x 379	5.50 140	5.62 143	2.38 60	13.00 330	0.25 6	0.62 16

A6044CHNFSS and A6044CHNFSS6 UL 508A Listed. The remaining catalog numbers are UL 50 Listed.
Purchase panels separately. Optional stainless steel, composite and aluminum panels are available for most sizes.

Hinge Cover



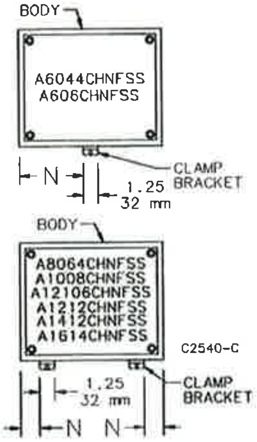




SECTION Y-Y

NOTE:
1. Optional panels are 14 gauge steel, conductive steel or stainless steel
2. Panel screws are #10-32 pan head

CLAMP BRACKET LOCATIONS



FEDERAL SIGNAL CORPORATION

Fireball®
Strobe Warning Light

Model FB2PST and FB2PST-I

LIGHT DUTY STROBE LIGHT

- Available in 12-24VDC, 120VAC and 240VAC
- Six dome colors
- 10,000 hour strobe tube
- Integrated 1/2-inch NPT pipe and surface mount
- Indoor/outdoor use
- Type 4X, IP66 enclosure
- UL and cUL Listed and CSA Certified

Federal Signal's brightest and most compact strobe light, the Fireball® emits a powerful "lightning bolt" flash of light. Approximately five inches tall and four inches in diameter and rated at 300 effective candela, the Fireball is an economical solution to a wide variety of stationary and vehicular warning requirements. The Fireball is available in 12-24VDC, 24VDC, 120VAC and 240VAC. All models are UL Listed and CSA Certified. The FB2PST is available in six colors – Amber, Blue, Clear, Green, Magenta, and Red.

The 24VDC Model FB2PST-I features a voltage in-rush limiting PCB design that provides greater compatibility with factory automation control systems and less electrical interference with in-rush sensitive devices.

The Fireball features a unique dome that twists off easily for quick dome and lamp replacements. The newly redesigned base features an integrated 1/2-inch NPT pipe mount base as well as the three holes required for surface mount configurations. Black epoxy paint is electrostatically applied to the base for superior corrosion resistance. The Fireball dome and base design provides a watertight, dust-tight and corrosion resistant Type 4X rating.

The FB2PST is designed for stationary pipe and surface mount applications.

The Fireball can be used in any application where a superior visual signal is needed. It is especially effective in the warning of industrial hazards, process control, status indication and in areas with high ambient noise levels.

Federal Signal's Fireball Strobe is a very low-maintenance warning light for industrial applications where a vibration-resistant light is required to signal an emergency or process status.

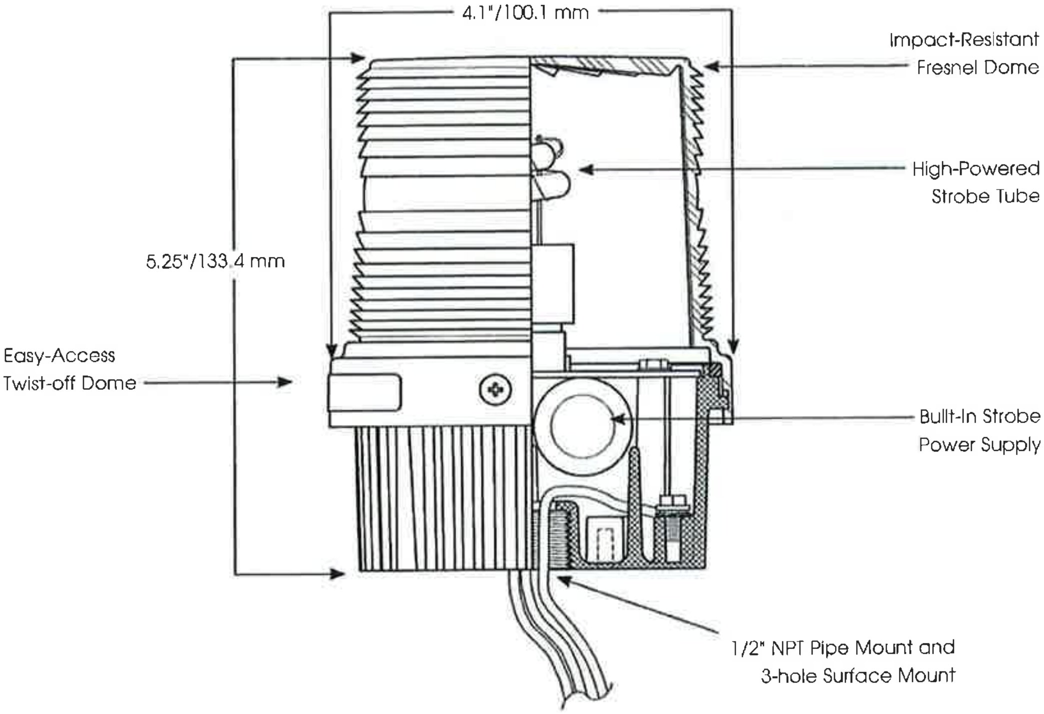
Model	Voltage	Operating Current	Flash Rate/ Minute	Candela Peak[1]	Candela ECP[2]	Mount
FB2PST-012-024_*_	12-24VDC	1.70-0.70 amps	80	1,000,000	300	1/2" NPT Pipe/Surface
FB2PST-I-024_*_	24VDC	0.70 amps (2.0 amp In-rush)	80	1,000,000	300	1/2" NPT Pipe/Surface
FB2PST-120_*_	120VAC 50/60Hz	0.25 amps	90	1,000,000	300	1/2" NPT Pipe/Surface
FB2PST- 240_*_	240VAC 50/60Hz	0.20 amps	90	1,000,000	300	1/2" NPT Pipe/Surface

** Indicates color: (A) Amber, (B) Blue, (C) Clear, (G) Green (M) Magenta or (R) Red*

[1] Peak candela is the maximum light intensity generated by a flashing light during its light pulse

[2] ECP (Effective Candela) is the intensity that would appear to an observer if the light were burning steadily

FIREBALL® STROBE WARNING LIGHT (FB2PST / FB2PST-1)



SPECIFICATIONS

Lamp Life:	10,000 Hours	10,000 Hours
Light Source:	Strobe tube	Strobe tube
Operating Temperature:	-31°F to 150°F	-35°C to 66°C
Net Weight:	2.0 lbs.	0.9 kg
Shipping Weight:	2.12 lbs.	0.96 kg
Height:	5.25"	133.4 mm
Diameter:	4.10"	100.1 mm

HOW TO ORDER

- Specify model, voltage and color
- Optional Accessories:
  Corner Bracket (LCMB2)*
  Wall Bracket (LWMB2)*
- Please refer to Model Number Index FB2PST beginning on page 372

* Not Type 4X rated.

REPLACEMENT PARTS

Description	Part Number	Description	Part Number
Dome, Amber	K8550320A	PC Assembly, 12-24VDC	K2001202C
Dome, Blue	K8550320A-01	PC Assembly, 120VAC	K200D866G
Dome, Clear	K8550320A-02	PC Assembly, 240VAC	K200D866G-01
Dome, Green	K8550320A-03	Strobe Tube, Series A4, A5, B	K8107177A
Dome, Red	K8550320A-04	120VAC Fuse	K148A155A-01
Dome, Magenta	K8550320A-05		

Appendix B

FMEA SPCS

FMEA - SPCS COMPONENT FAILURES

Component	Function	ID	Potential Failure Mode	Cause of Failure	Effects	S	O	SO	Safeguards	Method of Detection	Actions/ Comments
Seismic Switch	Seismic Switch normal power source is the non-safety electrical distribution system.	C1	Non-safety electrical distribution system fails. AC power fails low.	Utility power loss Tripped circuit breaker. Loose or disconnected wire	Power Cutoff Contactor hold in solenoid will deenergize. Safe state.	0	10	0	Branch circuit sizing Terminals torqued to mfs. Specs. Non-safety uninterruptable power supply used to feed SPCS branch circuts	Strobe light is lit. Observation of power outage.	Panelboard PP-13, the power source for both SPCS channels, recieves battery backup power from a non-safety uninterruptable power supply in the Utility Bldg. A loss of UPS power is a subset of this scenario where the strobe will not be lit.
		C2	AC power fails Voltage high	Lightning or switching induced transients Upstream mis-wiring or faults.	Possible damage to Seismic Switch electronics in both channels as a result of common power source. Safety function of both channels is compromised.	9	1	9	Overcurrent devices (Isolation fuse and non-safety circuit breakers). Surge Protection Shielding (combination of underground conduit, metallic conduit and metal enclosures). Indpendent, non-safety, branch circuits	Periodic inspection and testing	This failure mode has the potential to impact both channels. It is judged to be a very low probability failure for the reasons presented in Section 3.0.
Seismic Switch	Seismic Switch (sensor and relays) power source is 12VDC power supply and 8 hour backup battery	C3	Power supply output fails.	Overheating of components. Random component failure. Output fuse fails	Seismic Switch trouble relay is deenergized and Power Cutoff Contactor opens Safe state	0	7	0	Component environmental ratings.	Strobe light is lit Observation of power outage.	
Seismic Switch	Seismic sensor contains triaxial accelerometer with a setpoint for each axis of motion. Each must be calibrated to trip at the required setpoint.	C4	Seismic sensor fails in such a manner that it is unable to detect seismic activity and the internal diagnostic does not recognize the failure.	Overheating of components.	Possible failure of both Seismic Sensors as a result of common environments Safety function of both channels is compromised.	9	1	9	Component environmental ratings. Periodic inspection and testing. Seismic sensor self check failure puts system in safe state.	Periodic inspection and testing.	This is judged to be a low probability failure
		C5	Seismic sensor fails in such a manner that it is unable to detect seismic activity and the internal diagnostic does not recognize the failure.	Random component failure.	Safety function of one channel is compromised.	4	3	12	Component environmental ratings. Periodic inspection and testing. Seismic sensor self check failure puts system in safe state.	Periodic inspection and testing.	This is judged to be a low probability failure
		C6	Seismic sensor fails to detect seismic activity due to firmware failure.	Seismic sensor calibration problems. Seismic Switch wrong configuration.	Safety function of one channel is compromised.	4	3	12	Firmware QA. Factory and startup testing. Shaker table test of setpoint.	Periodic inspection and testing.	
		C7	Seismic sensor incorrectly indicates seismic activity.	Seismic sensor calibration problems. Seismic Switch wrong configuration. Seismic Switch is kicked or jarred.	Power off to site. Safe state.	0	8	0	Physical tamper protection. Seismic sensor mounted low with respect to ground level. Inertia block large mass. Factory and startup testing.	Strobe light is lit. Observation of site wide power outage.	

FMEA - SPCS COMPONENT FAILURES

Component	Function	ID	Potential Failure Mode	Cause of Failure	Effects	S	O	SO	Safeguards	Method of Detection	Actions/ Comments
Seismic Switch	Seismic Switch internal alarm relay changes state when seismic sensor indicates seismic activity.	C8	Relay fails de-energized. Voltage low.	Loose or disconnected wire. Open circuited relay coil. Stuck or welded relay contacts.	Safety function of one channel is compromised.	4	5	20	Relay rated for contactor hold-in coil inductive load and power supply short circuit current. Isolation devices.	Periodic inspection and testing.	Stnd. relay rating is 240VAC, 10A which is sufficient for planned load.
		C9	Relay fails energized. Voltage high.	Short circuited control wiring Seismic switch malfunction	Power off to site. Safe state.	0	3	0	Enclosure environmental ratings Terminals torqued to mfs. Specs.	Strobe light is lit. Observation of site wide power outage.	
		C10	Relay contact terminals or wiring is short circuit or grounded.	Conductive metal brackets or loose conductors fall across terminals	Safety function of one channel is compromised.	4	1	4	Seismically designed and qualified equipment mounting. Survivability testing.	Periodic inspection and testing	
Contactor	Contactor opens to interrupt power. Hold-in solenoid is de-energized by the Seismic Switch to open the contactor.	C11	Contactor fails closed. Electrical Failure.	Contactor welded shut. Short circuited control wiring. Conductive metal brackets or loose conductors fall across terminals.	Safety function of one channel is compromised.	4	2	8	Contactor ratings. Equipment mounting and anchors. Rigid conduit requirments. Conductor requirements. Enclosure environmental ratings. Terminals torqued to mfs. Specs.	Periodic inspection and testing.	
		C12	Contactor fails open. Electrical failure.	Loose or disconnected wire. Tripped fuse or circuit breaker.	Power lost to site. Safe condition.	0	7	0	Overcurrent devices (branch breaker and isolation fuse). Terminals torqued to mfs. Specs.	Strobe light is lit Observation of site wide power outage.	
	De-energizing hold in solenoid eliminates magnetic force. Contactor opens.	C13	Contactor fails closed. Mechanical failure.	Fouled, dirty, broken or frozen mechanism. Broken parts obstruct motion.	Safety function of one channel is compromised.	4	1	4	Equipment mounting and anchoring. Enclosure environmental ratings Survivability ratings.	Periodic inspection and testing.	
		C14	Contactor fails open. Mechanical failure.	Broken parts obstruct motion.	Power lost to site. Safe condition.	0	2	0	None required.	Strobe light is lit. Observation of site wide	

FMEA - SPCS COMPONENT FAILURES

Component	Function	ID	Potential Failure Mode	Cause of Failure	Effects	S	D	SO	Safeguards	Method of Detection	Actions/ Comments
Isolation Fuse Enclosure	Isolation is required between safety-class Seismic Switch and non-safety power distribution system.	C15	Isolation device fails. Short circuit.	Conductive metal brackets or loose conductors fall across fuse terminals.	Safety function of one channel is compromised.	4	1	4	Equipment mounting and anchors. Isolation fuse coordination and ratings. Maintain separation between non-safety incoming power and safety class wiring. Survivability testing.	Periodic inspection and testing.	
		C16	Isolation device fails. Open circuit.	Fuse fatigue. Downstream fault.	Seismic Switch internal relays configured to de-energize. Power off to site. Safe state.	0	8	0	None required	Strobe light is lit. Observation of site wide power outage.	
	Strobe light cannot fail in such a manner as to disable the safety function of the SPCS.	C17	Strobe light short circuits.	Insulation failure. Mechancial damage.	Isolation Fuse trips causing Power Cutoff Contactor hold in solenoid to deenergize. Safe state.	0	4	0	Isolation fuse ratings. Conductor requirements.	Observation of site wide power outage.	
Conductors	Safety system conductors carry 120VAC power and control signals.	C18	Conductors short together in such a manner as to inhibit the safety function.	Mechanical damage (crushing, mounting failure). Insulation failure.	Safety function of one channel is compromised.	4	1	4	Equipment mounting and anchoring. Rigid conduit requirments. Conductor requirements. Terminals torqued to mfs. Specs.	Periodic inspection and testing.	

FMEA - SPCS DESIGN BASIS ACCIDENT FAILURES

System	Function	ID	Potential Failure Mode	Cause of Failure	Effects	S	O	SO	Safeguards	Method of Detection	Actions/ Comments
Seismic Power Cutoff System	The SPCS is not required to perform its safety function during a design-basis fire, however if a fire causes the system to fail then notification is important.	B1	Most likely failure is that one of the contactors will open.	Fuel pool fire or wild fire of sufficient size to engulf both channels. Melting insulation causes fault on control or power circuit which trips circuit breaker or isolation fuse and the contactor opens.	Power lost to site. Safe state.	0	2	2	Separation of redundant channels. Overcurrent device (fuses and breakers).	Strobe light is lit. Personnel notice site wide power outage	Similar to failure scenario A1, there are subsets of this failure which result in the strobe light not being lit.
		B2	Unlikely failure is that the system fails in an unsafe condition.	Fuel pool fire or wild fire of sufficient size to engulf both systems. Melting components (seismic switch relays or power cutoff contactor) are fused in such a manner as to inhibit safety function in both channels.	Safety function compromised.	9	1	9	Physical separation of redundant channels. Limit combustibles. Fire propogation rating of conductors.	Functional test and inspect after any fire.	Recommend requirement for functional test and inspect after any fire. Recommend requirement for manned refueling operations.
Seismic Power Cutoff System	It is expected that the SPCS will perform its safety function early during any design basis seismic event thus mitigating the possibility of an ensuing fire.	B3	SPCS does not perform it's safety function during a seismic event.	SPCS is damaged by collapsing building debris in such a manner that both contactors are crushed in the shut position. SPCS is damaged as a result of equipment mounting, anchorage or support failure.	Safety function compromised.	9	1	9	Physical separation of redundant systems from buildings. Seismically designed and qualified equipment mounting.	Periodic testing and inspection.	
Seismic Power Cutoff System Bollards	Bollards reduce likelihood of offsite vehicle from impacting equipment.	B4	SPCS is damaged by runaway vehicle which crashes into system enclosures.	SPCS is damaged by runaway vehicle in such a manner that both contactors are crushed in the shut position.	Safety function compromised.	4	1	4	Seismically designed and qualified protection bollards. Reinforced concrete wall.	Periodic testing and inspection.	
Seismic Power Cutoff System Reinforced Wall	Reinforced concrete wall around SPCS protects equipment from damage by windborne projectiles	B5	SPCS conductors or components short circuit or are mechanically deformed in such a manner as to cause the contactor to remain closed.	SPCS is damaged by windborne projectile.	Safety function compromised.	4	1	4	Seismically designed and qualified protection bollards.	Periodic testing and inspection.	

Attachment 5

Failure Modes and Effects of Vehicle Barriers for the TA-63 TRU Waste Facility Project Phase B Design

Insert document 11-001-FMEA-002, Revision 0

WEIDLINGER-NAVARRO JV NORTHERN NM

Failure Modes and Effects Analysis of Vehicle Barriers for the TA-63 TRU Waste Facility Project Phase B Design

11-001-FMEA-002, Revision 0

September 11, 2012

Prepared for
Los Alamos National Laboratory
Los Alamos, New Mexico 87545

Reviewed Classification/UCNI

(Reviewed By)

Z# 121142

(Review Date) 9/27/12

(Classification) UNCLASSIFIED

WEIDLINGER-NAVARRO JV NORTHERN NM

Failure Modes and Effects Analysis of Vehicle Barriers for the TA-63 TRU Waste Facility Project Phase B Design

11-001-FMEA-002, Revision 0

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4200 West Jemez Rd., Ste. 301
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Contract 75181-000-09

Approvals:

Ja-Kael Luey 9/25/2012

Ja-Kael Luey, PE, Engineering Manager — Date

Brian Sullivan 9/21/12

Brian Sullivan, Project Manager — Date

Executive Summary

The Vehicle Barrier is a safety-class system designed to mitigate the risk of an external vehicle striking a Transuranic Waste Facility (TWF) Storage Building and impacting waste containers or striking the sealed source building by stopping all vehicles equal to or less than 10,000 lb. This analysis satisfies the requirement for a documented Failure Modes and Effects Analysis (FMEA) of safety-class systems. The FMEA includes both single-failure and design-basis, accident-failure analyses to determine what failure modes, if any, can prevent the system from performing its safety function. The analysis finds that there minimal risks associated with Vehicle Barriers ability to reliable perform the required safety function.

The analysis includes a description of the selected system. Since the Vehicle Barriers are a passive structural system, most failure modes are only identifiable via periodic inspection or observation. Facility operators will be required to verify the structural adequacy of the barriers by performing scheduled and periodic inspections and observations of the barrier. Although administrative actions are not necessarily the preferred defense, there is no other safeguard to verify the structural adequacy of the barrier.

The critical characteristics and recommended design features of the system are identified. Specific commercial systems, from more than one manufacturer, would meet the basic functional requirement identified and the means of obtaining a Commercial-Grade Dedication is possible.

Contents

Appendices

List of Tables

1.0 Introduction

With the location of the Transuranic Waste Facility (TWF) site at Los Alamos National Laboratory's (LANL's) Technical Area (TA)-63 along Pajarito Road, there is a risk of an external vehicle striking a Storage Building and impacting waste containers or striking the sealed source building. A safety-class, Management Level (ML)-1,vehicle barrier is required to stop all vehicles equal to or less than 10,000 lb. The *TA-63, Transuranic Waste Facility (TWF) Preliminary Documented Safety Analysis* (PDSA) (TWF-PDSA-12-001), indicates the likelihood of a heavy truck (greater than 10,000 lb) impact as beyond extremely unlikely.

A traffic speed study showed that the 85th percentile speed for Pajarito Road (West of TA-55) is about 55 mph. The PDSA criterion for the vehicle barrier is to stop a 10,000-lb vehicle moving at 55 mph before it strikes either a storage building or the sealed source building. This equates to a kinetic energy of 1.01×10^6 ft-lb.

To address this criterion, a U.S. Department of State (DOS) K12 barrier was selected. A K12, P1 barrier is designed to stop the cargo bed of an external vehicle weighing 15,000 lb and moving at a speed of 50 mph (a kinetic energy of 1.20×10^6 ft-lb) within 3 ft of impacting the barrier. The specific barrier chosen is a Gibraltar, marketed by Neu Security Services, LLC (NSS), K12 Cable Crash Fence (see Drawing C55443, Sheet C-5006).

This evaluation is intended to establish conformance with the requirement for a K12 vehicle barrier. This report contains the following:

1. A brief description of the selected system;
2. A review of the selected system's critical characteristics (Appendix A includes a referenced project drawings, vendor layout drawings, and vendor specification);
3. A review of standard industry tests; and
4. Failure Modes and Effect Analysis (FMEA) for the selected system (see Appendix B).

2.0 Description of the Selected Vehicle Barrier

Appendix A includes vendor drawings that detail the selected vehicle barrier and illustrates the necessary components. The system is primarily comprised of large end "terminal posts" and smaller "line posts" that form the anchorage of the barrier to the ground. Three cables are then run at specified heights to provide the means of arresting an impacting vehicle.

The vehicle barriers are to be located along the north side of the site, along Puye Road, and the east side of the site, along Pajarito Road (see Drawing C55443, Sheet C-1000, "Overall Site Plan"). A permanent chain-link fence is also provided. The posts on the fence will serve as the intermediate post.

Table 1 summarizes the components, safety classification, and function of each component in the selected system. Note that the final design is not complete. The items listed in Table 1 meet the basic functional requirements of the system, but have not been verified to meet the specific criteria and requirements for a safety-class system (i.e., commercial-grade dedication criteria).

Table 1. Selected Vehicle Barrier Component Summary.

Item	Identifier	Manufacturer's Part Number	Classification	Function
Foundations	F	N/A	Safety-Class ML-1	Designed to support posts and anchor barrier to the ground.
Terminal Post	TP	N/A	Safety-Class ML-1	Designed for energy absorption and to anchor the fence.
Kicker	K	N/A	Safety-Class ML-1	Designed for additional energy absorption to support the terminal post.
Corner Post	CP	N/A	Safety-Class ML-1	Designed for energy absorption and to anchor the fence line applications that intersect at a near 90 degree angle.
Line Post	LP	N/A	Safety-Class ML-1	Designed for energy absorption and maintaining cable design height.
Spelter Socket	SS	N/A	Safety-Class ML-1	Designed to secure the cable to the Terminal Post and/or Corner Post.
Cable Clamp	CC	N/A	Safety-Class ML-1	Designed to restrain the Cable and utilize the energy absorption capability of the Line Post and thereby localizing the energy during impact.
Intermediate Post	IP	N/A	Safety-Class ML-1	Needed to support the Spacer Plate.
Spacer Plate	SP	N/A	Safety-Class ML-1	Designed to maintain height of the Cables.
Cable	C	N/A	Safety-Class ML-1	Designed to contain and arrest a vehicle upon impact.

ML = Management Level.
N/A = not applicable.

2.1 Failure Modes and Effects Analysis of Selected Vehicle Barrier

Appendix B provides the FMEA for the selected system. The FMEA addresses failures that result from postulated individual component failures and postulated design-basis accidents.

Each failure is assigned a severity and occurrence index. Both indices range from 1 to 10. A severity index (S) of 1 represents a failure mode with an inconsequential effect on the ability of the system to perform its safety function. A severity index of 10 represents a failure mode that has catastrophic effects on the ability of the system to perform its safety function. An occurrence index (O) of 1 represents an extremely unlikely failure mode. An occurrence index of 10 represents an inevitable failure mode. The product of the severity index and the occurrence index (SO) is an indication of the relative risk associated with any particular failure.

The method of detection for each failure is listed in the FMEA. Failures result in a compromise of the ability of the system to perform its safety function. Since the vehicle barriers are a passive system, failures are only detectable via inspections or testing. The method of detection is used to subjectively weigh the severity index. In general, the items listed under "Safeguards" are used to help weigh the impact that method of detection has on the severity index.

2.2 Critical Characteristics and Design Features

Critical characteristics are identifiable and measurable properties or attributes of an item, which are critical to the item performing its safety function or can be used to provide assurance that the item received is the item specified. Critical characteristics include those properties or attributes that define an item's form, fit, and function essential to performing its safety function. All components of the vehicle barrier are commercial-grade items that are not subject to design or specification requirements unique to nuclear facilities. As such, a plan of how these items will be certified for use as safety-class, management-level components must be documented. The intent is that the items are ordered from the manufacturer or supplier on the basis of specifications set forth in the manufacturer's published product descriptions and either certified via a receipt inspection, which verifies the required attribute, performance testing analysis, or a combination of these methods.

The critical characteristics and expected certification method for the vehicle barrier components are listed below. Dimension tolerances were not provided, so it should be assumed the dimensions given are a minimum (shall be no less than) or maximum (shall be no greater than).

- Foundations – the footing for the Terminal Post shall be 3 ft (minimum) diameter by 8 ft (minimum) depth with a reinforced welded rebar cage (seven #3 rings spaced at 6 in. on center starting 4 in. from ground level and then three #3 rings space 14 in. on center with #5 vertical rebar allowing 3-in. cover) and shall be considered for installations where little or no subterranean obstructions are present. The concrete shall be 3,000 psi (minimum). Concrete shall be poured into the Terminal Post 20 in. (minimum) above the ground level. The footing for the Line Post is a 2 ft (minimum) diameter by 8 ft (minimum) depth diameter with a reinforced welded rebar cage (similar to Terminal Post) with concrete at 3,000 psi (minimum).
- Terminal Post – the height of the Terminal Post shall be 10 ft (minimum) with 4 ft (minimum) as measured from the ground surface to the top of the Terminal Post cap and 6 ft (minimum) below grade. The Terminal Post shall be 16 in. by 16 in. by 1/2 in. (minimum) constructed of hollow structural section (HSS) steel. The Terminal Post shall be galvanized after fabrication.
- Kicker – the Kicker shall be welded and angled off the Terminal Post. The top of the Kicker shall start at the bottom of the lowest cable and slope down and welded to a Footer Post. The Kicker shall be 4 -n. by 4-in. by 3/8-in. (minimum) HSS steel. The Footer Post shall be in a foundation identical to the Line Post. The Footer Post shall be 4-in. by 6-in. by 3/8-in. (minimum) HSS steel and shall be back filled entirely with concrete.
- Corner Post – the height of a Corner Post shall be 10 ft (minimum) with 4 ft (minimum) as measured from the ground surface to the top of the Corner Post cap and 6 ft (minimum) below grade. The Corner Post shall be 16 in. by 16 in. by 1/2 in. (minimum) constructed of HSS steel. The Corner Post shall be galvanized after fabrication.
- Line Post – the height of the Line Post shall be 10 ft (minimum) with 4 ft (minimum) as measured from the ground surface to the top of the Line Post cap and 6 ft (minimum) below grade. The Line Post shall be 12 in. by 6 in. by 1/2 in. (minimum) constructed of HSS steel. The Line Post shall be galvanized after fabrication.
- Spelter Socket – the Spelter Socket shall be open. The overall length shall be 12.5 in. (tolerance as specified by the manufacturer) with a cable opening of 2.5 in (tolerance as specified by the manufacturer). The Spelter Socket shall allow for a 2.5-in. (tolerance as specified by the manufacturer) pin and include a neck size of 2.5 in (tolerance as specified by the manufacturer).
- Cable Clamp – the Cable Clamp is installed within the Line Post and shall secure the Cable. The Cable Clamp shall be constructed of steel.

- Intermediate Post – the height of the line post shall be 5 ft-6 in. (minimum) with 4 ft (minimum) as measured from the ground surface to the top of the Intermediate Post cap and 18 in. (minimum) below grade. The Intermediate Post shall be constructed of steel, Schedule 40, 1.90 in. OD (minimum) and shall be in an un-reinforced concrete footing measuring 1 ft. (minimum) in diameter and 18 in. (minimum) deep.
- Spacer Plate – the shall be constructed of two steel plates welded together and to the Intermediate Post with 1/4 in. all-around field weld.
- Cable – the Cable shall be installed at the design heights of: Top = 42 in. (tolerance as specified by the manufacturer), Middle = 36 in. (tolerance as specified by the manufacturer), and Lower = 30 in. (tolerance as specified by the manufacturer). The Cable shall be secured at the Terminal Post by a Spelter Socket and within the Line Post by the Cable Clamp. The design height of the Cable shall be maintained between the Terminal Post and the Line Post and between the Line Post and the Intermediate Post by the Spacer Plate welded to the Intermediate Post or existing fence post. The Cable size is 1-1/8 in. (minimum) with galvanized strands.

Design features are component interconnection, interface, or installation methods which protect against failure of the system components. The design features required for the vehicle barrier systems are listed below. These items are in addition to the individual critical characteristics of the components listed above.

- Soil Conditions – the barrier is designed for installation in standard compact soil. The soil shall be well drained and compacted. If poor soil conditions are encountered (i.e., "sugar" sand, expansive clay, or ground water – none of which exist at the TWF site) it is important to make the necessary adjustments to meet standard soil requirements.
- Post Spacing (designed to achieve P1 rating) – the maximum distance between Terminal Posts shall be 2,000 ft on center. The maximum distance between Terminal Posts and Footer Posts shall be 8 ft on center. The maximum distance between Terminal Posts and Line Posts, Corner Posts and Line Posts, and Line Posts to Line Posts shall be 20 ft on center. The maximum distance between Intermediate Posts and either Terminal Posts, Line Posts, or Corner Posts shall be 10 ft on center.

3.0 Conclusions and Recommendations

The analysis indicates a majority of the potential failure modes have an SO rating of less than 10 (out of a possible 100), which makes the risk very low. In addition, most of the potential failure modes can be addressed through simple periodic inspections and observations of the vehicle barrier fence. The highest risk failures based on the SO rating are listed in Table 2.

All of these events require inspections and observations post-installation/construction. These inspections and observations should be routine periodic inspections and maintenance requirement to ensure the vehicle barriers are capable of performing the required safety function.

Further, it was noted in Section 4.6 of the *Draft Report Geotechnical Investigation TRU Waste Facility Technical Area 63 (TA-63)* (11-002-GRPT-002), that adequate existing soil structures exist for the vehicle barriers.

Thus, it can be concluded that the selected vehicle barrier can be certified and maintained to perform the required safety function using commercial-grade dedication of standard products available.

Table 2. Comparison of Failures.

ID	Failure Mode	Effects	S	O	SO
C6	Insufficient cable strength – prior vehicle accident weakens cables.	Reduced structural integrity below DOS K12 P1 criteria	8	6	48
C4	Insufficient cable strength – corrosion of structural steel.	Reduced structural integrity below DOS K12 P1 criteria	7	5	35
P6	Insufficient post strength – prior vehicle accident weakens post(s).	Reduced structural integrity below DOS K12 P1 criteria	6	5	30
F4	Insufficient concrete strength – erosion/aging of concrete.	Reduced structural integrity below DOS K12 P1 criteria	4	6	24
P4	Insufficient post strength – corrosion of structural steel.	Reduced structural integrity below DOS K12 P1 criteria	3	6	18

C# = Cable-related.
DOS = U.S. Department of State.
F# = Foundation-related
O = Occurrence (1, extremely unlikely, to 10, inevitable).
P# = Post-related (could relate to any type of post)
S = Severity (1, inconsequential effect, to 10, catastrophic effect).
SO = S x O.

4.0 References

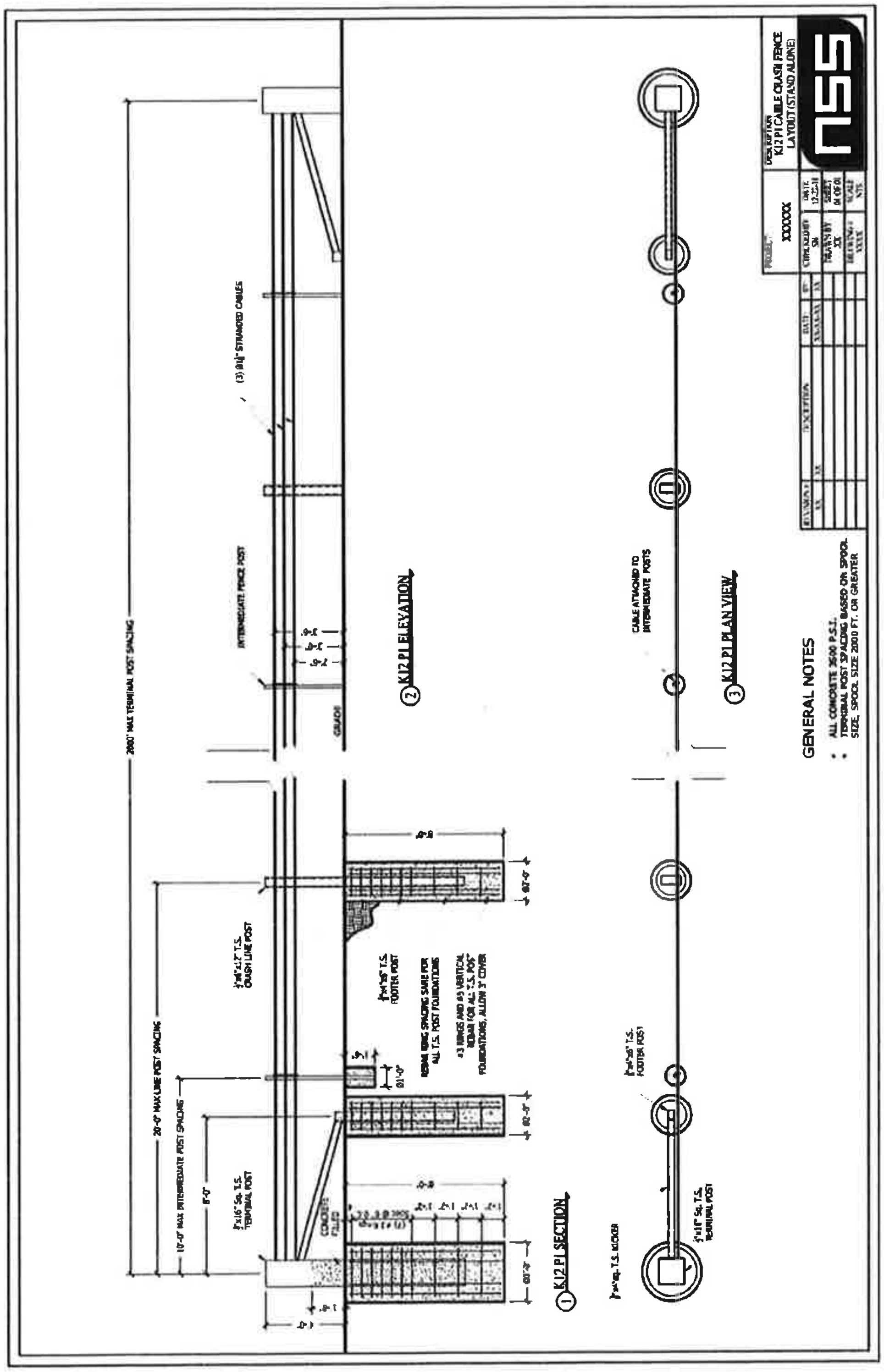
11-002-GRPT-002, *Draft Report Geotechnical Investigation TRU Waste Facility Technical Area 63 (TA-63)*, Revision A, Kleinfelder, Albuquerque, New Mexico.

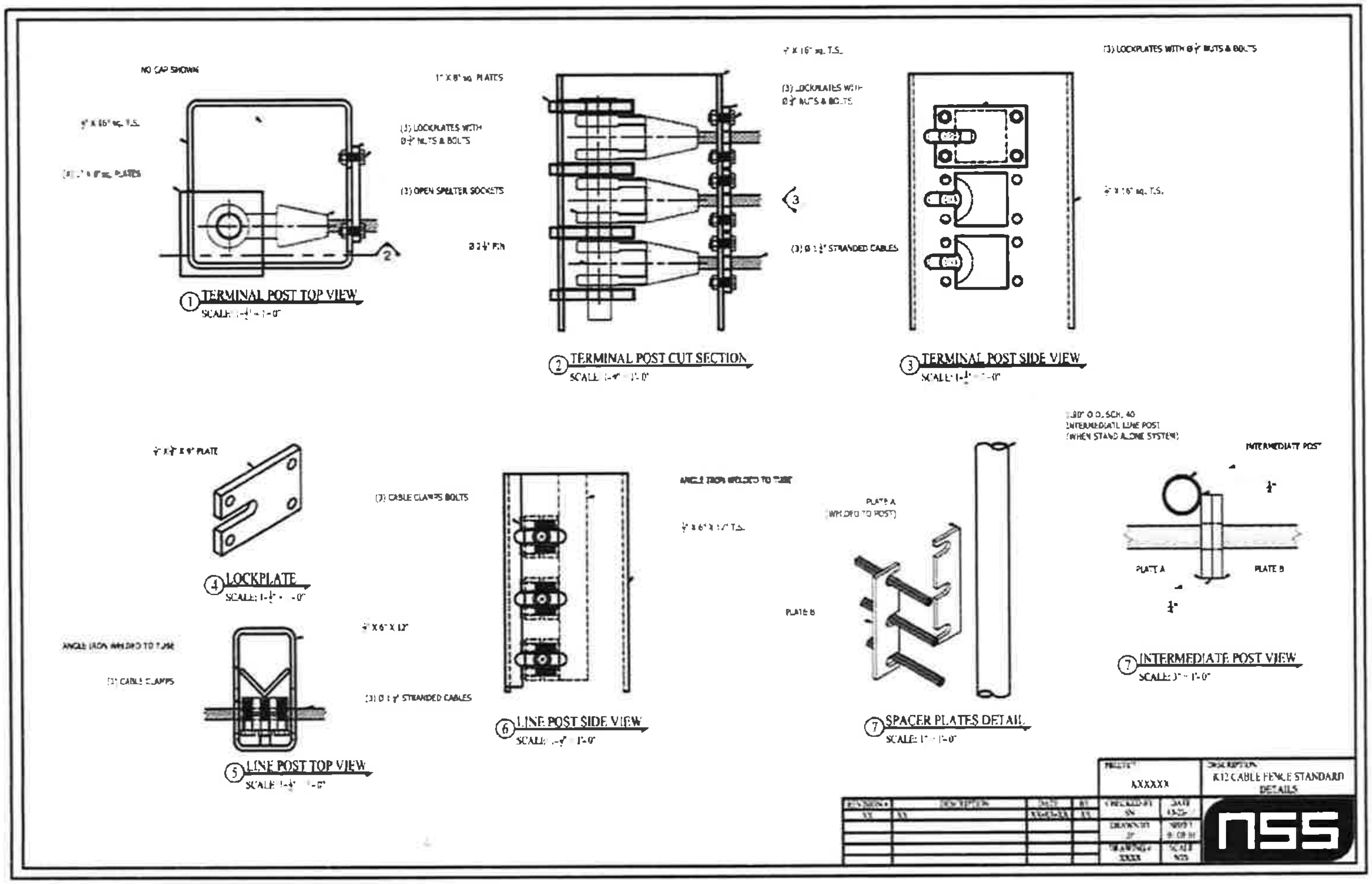
Drawing C55443, Sheet C-1000, “Overall Site Plan,” Revision 0, Weidlinger-Navarro Northern New Mexico JV, Los Alamos, New Mexico.

TWF-PDSA-12-001, *TA-63, Transuranic Waste Facility (TWF) Preliminary Documented Safety Analysis,* Revision 0, Los Alamos National Laboratory, Los Alamos, New Mexico.

Appendix A

Referenced Drawing and Vendor Drawings, Specifications, and Certification


2000' MAX TERMINAL POST SPACING
20'-0" MAX LINE POST SPACING
10'-0" MAX INTERMEDIATE POST SPACING
8'-0"
(3) 3/4" STRANDED CABLES
INTERMEDIATE FENCE POST
2'-6"
2'-0"
2'-6"
GRADE
CRASH LINE POST
TERMINAL POST
CONCRETE FILLED
FOOTER POST
REBAR RING SPACING SAME FOR ALL T.S. POST FOUNDATIONS
#3 RINGS AND #5 VERTICAL REBAR FOR ALL T.S. POST FOUNDATIONS, ALLOW 3" COVER
1'-0"
4'-0"
8'-0"
T.S. KICKER
CABLE ATTACHED TO INTERMEDIATE POSTS
① K12 PI SECTION
② K12 PI ELEVATION
③ K12 PI PLAN VIEW
GENERAL NOTES
ALL CONCRETE 3500 P.S.I.
TERMINAL POST SPACING BASED ON SPOOL SIZE. SPOOL SIZE 2000 FT. OR GREATER
REVISION
DESCRIPTION
DATE
BY
PROJECT
XXXXXX
DESCRIPTION
K12 PI CABLE CRASH FENCE LAYOUT (STAND ALONE)
CHECKED BY
DRAWN BY
DRAWING #
DATE
SHEET
SCALE
NTS
NSS


NO CAP SHOWN
X 16" sq. T.S.
1" X 8" sq. PLATES
(3) LOCKPLATES WITH Ø NUTS & BOLTS
(3) OPEN SPELTER SOCKETS
Ø PIN
① TERMINAL POST TOP VIEW
SCALE: 1-" = 1'-0"
② TERMINAL POST CUT SECTION
SCALE: 1-" = 1'-0"
X 16" sq. T.S.
(3) LOCKPLATES WITH Ø NUTS & BOLTS
(3) Ø 1" STRANDED CABLES
③ TERMINAL POST SIDE VIEW
SCALE: 1-" = 1'-0"
(3) LOCKPLATES WITH Ø NUTS & BOLTS
X 16" sq. T.S.
PLATE
④ LOCKPLATE
SCALE: 1-" = 1'-0"
ANGLE IRON WELDED TO TUBE
(3) CABLE CLAMPS
X 6" X 12"
(3) Ø 1" STRANDED CABLES
⑤ LINE POST TOP VIEW
SCALE: 1-" = 1'-0"
(3) CABLE CLAMPS BOLTS
ANGLE IRON WELDED TO TUBE
X 6" X T.S.
⑥ LINE POST SIDE VIEW
SCALE: 1-" = 1'-0"
PLATE A
(WELDED TO POST)
PLATE B
⑦ SPACER PLATES DETAIL
SCALE: 1" = 1'-0"
.80" O.D. SCH. 40
INTERMEDIATE LINE POST
(WHEN STAND ALONE SYSTEM)
INTERMEDIATE POST
PLATE A
PLATE B
⑦ INTERMEDIATE POST VIEW
SCALE: 3" = 1'-0"
PROJECT
XXXXXX
DESCRIPTION
K12 CABLE FENCE STANDARD DETAILS
REVISION
DESCRIPTION
DATE
BY
XX
XX
XX/XX/XX
XX
CHECKED BY
SN
DATE
DRAWN BY
SHEET
DRAWING
XXXX
SCALE
NTS
NSS

PROCUREMENT SPECIFICATION FOR NSS K12 CABLE CRASH FENCE

DOS CERTIFIED K12 RATED ANTI-RAM VEHICLE BARRIER

SYNOPSIS

This specification defines a CERTIFIED CRASH TESTED ANTI-RAM VEHICLE CABLE BARRIER SYSTEM Model NSS K12 CABLE CRASH FENCE, for placement as a Passive Barrier to Protect High-Risk Assets, Facilities, and Personnel and serves to contain vehicles from unauthorized access.

The NSS K12 CABLE CRASH FENCE Anti-Ram Vehicle Barrier System consists of incorporating TERMINAL POSTS, CORNER POSTS, LINE POSTS, INTERMEDIATE POSTS, SPACER PLATES, CABLE CLAMPS, SPELTER SOCKETS and CABLE.

The system shall function as a part of a vehicular arresting security strategy.

1.0 PATENT LICENSE

The certified NSS K12 CABLE CRASH FENCE shall be fully licensed for manufacture under U.S. Patents or patents pending.

1.1 CERTIFICATION

1.1.1 DOS CERTIFICATION. The Department of State's (DOS) physical security concept is to create a layered or "tiered" defensive system which consists of both active and passive perimeter barriers to delay intruders. The DOS has a performance standard and testing procedure for passive perimeter barriers designated as "anti-ram barriers." The current standard is SD-STD-02.01, Vehicle Crash Testing of Perimeter Barriers, Revision A, dated March 2003. The NSS K12 CABLE CRASH FENCE was tested and certified under this standard.

1.1.2 DOS RATING. The NSS K12 CABLE CRASH FENCE has a DOS K12 Rating. The rating of the barrier is determined when a 15,000lb (6804kg) gross-weight vehicle impacts a barrier from a perpendicular direction. A K12 rating is achieved when a vehicle traveling at a nominal speed of 50mph (80kph) is successfully arrested by the barrier from the perpendicular direction. For a P1 rating, the penetration of the cargo bed must not exceed 1 meter beyond the pre-impact inside edge of the barrier. For a P2 rating, the penetration of the cargo bed must not exceed 1.01 to 7M, P3; 7.01 to 30M, and P4; greater than 30M.

1.1.3 DOS TESTED. The NSS K12 CABLE CRASH FENCE shall be successfully tested and certified by a Department of State (DOS) approved certification testing facility.

2.0 SYSTEM CONFIGURATION

The system configuration shall include the following:

2.1 BARRIER STANDARD CONFIGURATION

2.1.1 Barrier Application. The NSS K12 CABLE CRASH FENCE shall be configured in accordance to the site conditions. The Barrier was designed for installation in standard compact soil. The soil should be well drained and compacted. If poor soil conditions are encountered (i.e. "sugar" sand, expansive clay or ground water) it is important to make the necessary adjustments to meet standard soil requirements. In some cases, it may require that a qualified engineer be consulted for soil investigation and engineering.

2.2 CONSTRUCTION

2.2.1 FOUNDATION. The typical footing for the TERMINAL POST is a 3ft (.914M) diameter by 8ft (2.438M) depth with a reinforced welded rebar cage shall be considered for installations where little or no subterranean obstructions are present. The concrete shall be 3,000psi (20.68mpa). The typical footing for the LINE POST is a 2ft (.61M) diameter by 8ft (2.438M) depth diameter with a reinforced welded rebar cage with concrete at 3,000psi (20.68mpa).

2.2.1 TERMINAL POST. The height of the TERMINAL POST shall be 10ft (3.048M) with 4ft (1.219M) as measured from the ground surface to the top of the TERMINAL POST cap and 6ft (1.829M) below grade. The TERMINAL POST shall be a 16in x 16in x 1/2in (406.4mm x 406.4mm x 12.7mm) constructed of structural steel. The TERMINAL POST shall be galvanized after fabrication. The TERMINAL POST is designed for energy absorption and to anchor the NSS K12 CABLE CRASH FENCE.

2.2.2 CORNER POST. The height of the CORNER POST shall be 10ft (3.048M) with 4ft (1.219M) as measured from the ground surface to the top of the CORNER POST cap and 6ft (1.829M) below grade. The CORNER POST shall be a 16in x 16in x 1/2in (406.4mm x 406.4mm x 12.7mm) constructed of structural steel. The CORNER POST shall be galvanized after fabrication. The CORNER POST is designed for energy absorption and to anchor the fence line applications that intersect at a near 90 degree angle.

2.2.3 LINE POST. The height of the LINE POST shall be 10ft (3.048M) with 4ft (1.219M) as measured from the ground surface to the top of the LINE POST cap and 6ft (1.829M) below grade. The LINE POST shall be a 12in x 6in x 1/2in (304.8mm x 152.4mm x 12.7mm) constructed of structural steel. The LINE POST shall be galvanized after fabrication. The LINE POST is designed for energy absorption and maintaining CABLE design height.

2.2.4 SPELTER SOCKET. The SPELTER SOCKET shall be open. The overall length shall be 12.5in (317.5mm) with a cable opening of 2.5in (63.5mm). The SPELTER SOCKET shall allow for a 2.5in (63.5mm) pin and include a neck size of 2.5in (63.5mm). The SPELTER SOCKET is designed to secure the CABLE to the TERMINAL POST and/or CORNER POST.

2.2.5 CABLE CLAMP. The CABLE CLAMP is installed within the LINE POST and shall secure the CABLE. The CABLE CLAMP shall be constructed of steel. The CABLE CLAMP is designed to restrain the CABLE and utilize the energy absorption capability of the LINE POST and thereby localizing the energy during impact.

2.2.6 INTERMEDIATE POST. The INTERMEDIATE POST shall be constructed of steel, Schedule 40, 0.154in (3.912MM) thickness, 2.375in (60.33mm) OD, and needed to support the SPACER PLATE. The INTERMEDIATE POST is not used if the NSS K12 CABLE CRASH FENCE application is retrofitted to an existing fence.

2.2.7 SPACER PLATE. The SPACER PLATE shall be constructed of steel. The SPACER PLATE is welded to the INTERMEDIATE POST to maintain design height of the CABLE. If INTERMEDIATE POST is not needed due to an existing fence line, the SPACER PLATE is welded to the typical fence post of the existing fence.

2.2.8 CABLE. The CABLE shall be installed at the design heights of: Top – 42in (1066.8mm), Middle – 36in (914.4mm) and Lower – 30in (762mm). The CABLE shall be secured at the TERMINAL POST by a SPELTER SOCKET and within the LINE POST by the CABLE CLAMP. The design height of the CABLE shall be maintained between the TERMINAL POST and the LINE POST and between the LINE POST the INTERMEDIATE POST by the SPACER PLATE welded to the INTERMEDIATE POST or existing fence post. The CABLE size is 1 1/8in (28.575mm) with galvanized strands. The CABLE shall contain and arrest a vehicle upon impact.

2.3 FUNCTIONALITY

2.3.1 The maximum span of CABLE between two TERMINAL POSTS shall not exceed 2000 linear feet (609.6M).

2.3.2 All Cable Crash Fence materials (with the exception of concrete, rebar, and temp braces for setting posts) to be provided by manufacturer.

2.3.3 Manufacturer shall furnish installation instructions.

3.0 PERFORMANCE

The following performance criteria be apply:

3.1 EXPERIENCE

3.1.1 The NSS K12 CABLE CRASH FENCE manufacturer shall have specialized in manufacturing cable barrier systems.

3.2 QUALIFICATION TESTS

3.2.1 The NSS K12 CABLE CRASH FENCE design shall have successfully passed actual full-scale crash tests conducted by a qualified independent agency.

3.2.2 Crash Test Certification. The NSS K12 CABLE CRASH FENCE shall be certified in accordance with the US Department of State standard for K12 testing as called out in the DOS testing standard SD-STD-02.01, Revision A, dated March 2003.

3.2.3 Reduced Risk. The NSS K12 CABLE CRASH FENCE shall, by design, inherently reduce the risk of vehicular terroristic attempts and success of such attempts toward the secured asset facility and the occupants of such facility.

3.2.4 The NSS K12 CABLE CRASH FENCE vehicle barrier shall be designed to arrest and immobilize the vehicle attempting to gain unauthorized entry.

3.2.5 The NSS K12 CABLE CRASH FENCE shall be designed to successfully arrest a 15,000lb (6804kg) gross weight vehicle impacting the anti-ram vehicle barrier from a perpendicular direction traveling at a nominal speed of 50mph (80kph). For a P1 rating, the penetration of the cargo bed must not exceed 1 meter beyond the pre-impact inside edge of the barrier. For a P2 rating, the penetration of the cargo bed must not exceed 1.01 to 7M, P3; 7.01 to 30M, and P4; greater than 30M.

4.0 ENVIRONMENTAL DATA

The following environmental corrosion controls shall be present in the manufacturing process:

4.1 The TERMINAL POST, CORNER POST, AND LINE POST, are hot-dipped galvanized to ASTM A123 with coating thickness of 1.7oz/ft^2 (530 g/m^2).

5.0 QUALITY ASSURANCE PROVISIONS

The following quality controls shall present in the manufacturing process.

5.1 QUALITY CONTROL

5.1.1 Principal Components of the NSS K12 CABLE CRASH FENCE shall be manufactured according to industry safety standards.

5.1.2 Workmanship. The barrier system components shall have a finished look in appearance and workmanship.

5.1.3 Finish. The finish is galvanized. Powder coat and paint processing is an option and will be visually inspected and verified against order information and shall have a finished look in appearance and workmanship.

6.0 PREPARATION FOR SHIPMENT

6.1 SHIPPING ASPECT

6.1.1 The NSS K12 CABLE CRASH FENCE shall be crated or mounted on pallets/skids as necessary to facilitate ease of transport and prevent damage from handling. Packaging shall be of sufficient structural integrity to enable the assembly to be lifted and transported by pallet jack, forklift, or crane.

7.0 MANUFACTURER'S DATA

The following information shall be provided to end user:

7.1 DRAWINGS AND INSTALLATION INSTRUCTIONS.

7.1.1 The NSS K12 CABLE CRASH FENCE Anti-Ram Vehicle Barrier drawings, installation, and specification shall be sent to purchaser with the order. Electronic versions can be supplied to customer for ease of utility. Installation shall be performed according to the manufacturer's instructions. Verify all component locations with contract drawings and shop drawings.

7.1.2 Any disagreement between the Plans, Specifications, and Ordinances, must be called to the attention of the Contractor before signing of the shop drawings. After the shop drawings have been signed, the Contractor is responsible for having all work meet requirements of the governing ordinances.

8.0 DISCLAIMER

Please note. Due to the nature and intended use of this technology, special provision and consideration must be given to the specific placement, K Rating selection and site conditions associated with the installation of the NSS K12 CABLE CRASH FENCE. Special care must be undertaken with regard to the installation, use and maintenance of any device designed as a vehicle barricade, especially, those equipped for traffic control capabilities.

It is strongly recommended that a traffic or safety engineer and or architect be consulted prior to the installation of the NSS K12 CABLE CRASH FENCE. NSS Materials can also offer assistance in the design of system operation, barrier controls, and integration but is not qualified to offer engineering services for traffic or safety.

9.0 PROCUREMENT SOURCE

The NSS K12 CABLE CRASH FENCE Anti-Ram Vehicle Barrier shall be purchased from:

NSS, LLC.
400 West 15th Street
Austin, TX 78701
Phone (512) 469-9980
FAX (512) 686-3343
Email: mmcbride@neusecurity.com

United States Department of State

Washington, D.C. 20520

OCT 22 2007

Gibraltar
320 Southland Drive
Burnett, Texas 78611

Attention: Mr. Bill Neusch

Dear Mr. Neusch,

Based on a request from your company, a technical representative of the Department of State (DOS) recently reviewed the vehicle crash test data from a DOS approved test facility. Upon review of the crash test data provided by the test facility it has been determined that your company's anti-ram vehicle barrier meets the DOS certification standards for vehicle barriers. This testing and analysis was conducted under the current provisions of SD-STD-02.01, Revision A, *Test Method for Vehicle Crash Testing of Perimeter Barriers and Gates*, dated March 2003.

Company/Manufacturer:	Gibraltar
Test Date:	June 14, 2007
Test Facility:	Texas Transportation Institute
Test Report Number:	400001-GIB1
Model Name/Number:	Gibraltar K12 Cable Crash Fence
Barrier Rating:	K12
Brief Description:	3-Cable fence system

The above vehicle barrier system will be placed on the DOS list of certified equipment that is available for use by architects and planners. Your product still has to compete with other bidding manufacturers who are certified with the same classification. We cannot guarantee that your product will be chosen by architects that design the facilities.

Thank you for your interest and endeavors in protecting our personnel and facilities overseas.

Sincerely yours,

Charles D. Brandeis

Charles Brandeis
Division Chief
Physical Security Division
Bureau of Diplomatic Security

Appendix B

Failure Modes and Effects Analysis

Identifier	Function	Failure Mode	Cause	Effects	S	O	SO	Method of Detection	Safeguards	Actions/ Comments
SC1	Reduce likelihood of an offsite vehicle from impacting building structures or waste containers	Poor soil conditions	Inadequate site soil	Reduced structural integrity below DOS K12 PI criteria	4	3	12	Testing	Follow recommendations in Section 4.6 of 11-002-GRPT-002	N/A
SC2			Erosion		4	3	12	Observation	Periodic observation of site soil conditions	N/A
F1		Insufficient foundation size(s)	Concrete pour not to required specifications		4	2	8	Inspection	Inspection during construction pour	N/A
F2		Insufficient concrete strength	Concrete strength below 3,000 psi		4	2	8	Testing	Testing cylinders poured during construction	N/A
F3			Rebar type and spacing not to required specifications		4	2	8	Inspection	Inspection during construction prior to concrete pour	N/A
F4			Erosion/aging of concrete		4	6	24	Observation	Periodic observation of foundation concrete	N/A
F5			Damage to foundations during seismic event		4	1	4	Inspection	Inspection of foundations following seismic event	N/A
P1		Insufficient post strength	Incorrect post size used		3	1	3	Inspection	Inspection of posts prior to construction	N/A
P2			Incorrect post material used		2	1	2	Inspection	Inspection of post material certifications prior to construction	N/A
P3			Insufficient post height or post depth in concrete footing		4	1	4	Inspection	Construction inspection	N/A
P4			Corrosion of structural steel		3	6	18	Inspection	Periodic inspection of posts	N/A
P5			Fire event damages steel		4	1	4	Inspection	Inspection of posts following fire event	N/A
P6			Prior vehicle accident weakens post(s)		6	5	30	Observation	Periodic observation for vehicle damage	N/A
C1		Insufficient cable strength	Incorrect cable size used		8	1	8	Inspection	Inspection of cables prior to construction	N/A

Identifier	Function	Failure Mode	Cause	Effects	S	O	SO	Method of Detection	Safeguards	Actions/ Comments
C2			Incorrect cable material used		8	1	8	Inspection	Inspection of cable material certifications prior to construction	N/A
C3			Incorrect top, middle, bottom cable heights		4	2	8	Inspection	Construction Inspection	N/A
C4			Corrosion of structural steel		7	5	35	Inspection	Periodic inspection of cables	N/A
C5			Fire event damages steel		8	1	8	Inspection	Inspection of cables following fire event	N/A
C6			Prior vehicle accident weakens cables		8	6	48	Observation	Periodic observation for vehicle damage	N/A
C7			Incorrect clamping of cable to posts		4	3	12	Inspection	Inspection after installation during construction	N/A
C8			Incorrect connection (welding or sagging of cable) of spacer plate to posts		4	3	12	Inspection	Inspection after installation during construction	N/A
SP1		Insufficient fence strength (besides failures mentioned above)	Improper spacing (> 2,000 ft) of Terminal Posts		6	1	6	Inspection	Inspection/verification of spacing after construction installation	N/A
SP2			Improper spacing between posts (> 20 ft)		6	1	6	Inspection	Inspection/verification of spacing after construction installation	N/A
SP3			Improper spacing between posts (> 10 ft)		6	1	6	Inspection	Inspection/verification of spacing after construction installation	N/A
SP4			Seismic event cause movement of posts		4	1	4	Inspection	Inspection/verification of post spacing following seismic event	N/A

C# = Cable-related.
DOS = U.S. Department of State.
F# = Foundation-related
N/A = not applicable.
O = Occurrence (1, extremely unlikely, to 10, inevitable).
P# = Post-related (could relate to any type of post)
S = Severity (1, inconsequential effect, to 10, catastrophic effect).
SC# = Soil Conditions-related
SO = S x O.
SP# = Spacing-related