Conceptual Design Report

NUCLEAR MATERIALS STORAGE FACILITY RENOVATION

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Part V - Structural / Seismic Investigation
Section A Report
**Existing Conditions Calculations/
Supporting Information**

Los Alamos
National Laboratory
July 14, 1995

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CONCEPTUAL DESIGN REPORT

JULY 14, 1995

FOR

LA-UR96-1

LINE ITEM PROJECT

NUCLEAR MATERIALS STORAGE FACILITY RENOVATION

AT THE

LOS ALAMOS NATIONAL LABORATORY

Project Identification Number 11818

Technical Area 55

Building PF-41

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DESIGN/BUILD ACQUISITION STRATEGY

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I. DETAILED CONSTRUCTION ANALYSIS

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SUPPORTING INFORMATION

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F I N A L

**PRELIMINARY STRUCTURAL EVALUATION OF THE NMSF FACILITY
LOS ALAMOS NATIONAL LABORATORY
LOS ALAMOS, NEW MEXICO**

**Prepared By
ICF Kaiser Engineers, Inc.**

JULY 1995

EXECUTIVE SUMMARY

The existing Nuclear Material Storage Facility (NMSF), PF-41, is located in Technical Area TA-55 at the Los Alamos National Laboratory in the State of New Mexico. Original design documents for the facility are incomplete; original design calculations, specifications, and criteria are not available. This report and associated calculations document a preliminary structural seismic evaluation of the existing NMSF.

A potential change of function for the facility is being explored. The change involves incorporating natural-convection-cooled dry storage capabilities for high-level radioactive material within the boundaries of the existing NMSF structure. A conceptual structural modification to the existing facility has been developed. The conceptual structural modification is intended to satisfy the upgraded functional and operational requirements that the dry storage facility would be subjected to.

The existing structure and the modified structure are evaluated using simplified, conservative methods. Input loads are consistent with those specified for Moderate Hazard (MH) facilities with Performance Category 3 Classification, per Department of Energy Standard DOE-STD-1020-94.

The simplified, conservative methods used in the current preliminary structural seismic evaluation are consistent with the conceptual design stage of the structural modifications to the existing NMSF building. A significantly more detailed and complete analysis and evaluation is required for full compliance with current DOE requirements. Detailed analysis is expected to take place at the Title Design stage for the NMSF facility.

The results of this preliminary evaluation indicate that the as-built NMSF building structure could be shown to be adequate to withstand the loads specified by current DOE standards for Performance Category 3 structures.

This preliminary evaluation also shows that the conceptual structural modifications envisioned for the proposed change of function of the NMSF building are feasible, and could be implemented so that the resulting structure adequately meets DOE requirements for Performance Category 3 structures.

Most of the structural strengthening effort required is concentrated in the west wall of the structure, in the detailing of the wall along line No. 2, and in the roof over the administrative area.

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1.0 INTRODUCTION

The existing Nuclear Material Storage Facility (NMSF), PF-41, is located in Technical Area TA-55 at the Los Alamos National Laboratory in the State of New Mexico. Original design documents for the facility are incomplete; original design calculations, specifications, and criteria are not available. This report and associated calculations document a preliminary structural seismic evaluation of the existing NMSF.

A potential change of function for the facility is being explored. The change involves incorporating natural-convection-cooled dry storage capabilities for high-level radioactive material within the boundaries of the existing NMSF structure. A conceptual structural modification to the existing facility has been developed. The conceptual structural modification is intended to satisfy the upgraded functional and operational requirements that the dry storage facility would be subjected to.

The existing structure and the modified structure are evaluated using simplified, conservative methods. Input loads are consistent with those specified for Moderate Hazard (MH) facilities with Performance Category 3 classification, per Department of Energy Standard DOE-STD-1020-94. Compliance with current DOE/LANL structural evaluation guidelines (1,2), as described in Section 3.0 of this report, is examined.

This report and the associated calculations document the criteria, procedure, and results of structural evaluation for the NMSF building in its "as-built" configuration per the original design drawings by Burns and Roe Pacific (14), and the NMSF building in its modified configuration per ICF Kaiser preliminary drawings (15,16) and final 100% Draft Conceptual Design Report (25).

For details of engineering calculations, refer to ICF Kaiser Calculation Numbers 42552-S-0001 and 4552-S-0002 (12,13).

2.0 SCOPE

As part of the current scope work, the existing "as-built" and conceptually modified NMSF buildings are evaluated for compliance with current seismic structural DOE evaluation guidelines using simplified, conservative procedures. Requirements are described in Section 3.0 of this report. Potential problem areas are identified, and possible corrective concepts are provided.

The structural evaluations make use of simplified mathematical models of the building. Sufficient detail is included to address the adequacy of only the major load-carrying structural components of the NMSF facility.

The scope of seismic evaluation is in accordance with the guidelines of the LANL Structural Standard (1), DOE Standard 1020-94 (2), and other required industry standards including UBC (4) and ASCE-7 (3). In the current evaluation, considerations are given to accidental torsion loads, soil-structure interaction, lateral soil pressure, and thermal stresses (for the modified structure only). The magnitude of the loads and the considerations for their combined effects are described in Section 3.0.

The analysis procedure and results of evaluation of the as-built structure are presented in Section 4.0 of this report. The structural analysis and evaluation results of the modified NMSF building are included in Section 5.0. This evaluation addresses the conceptual stage of the proposed structural modifications to the NMSF building. The structural evaluations are on a sampling basis and involve the main structural members of the building. A significantly more detailed analysis and complete evaluation of all structural components of the building is expected during evaluation of the final stage of the design.

A preliminary structural evaluation of the existing buried access tunnel, and its interaction with the NMSF building, is also performed in this study. The evaluation procedure and results of the analysis are presented in Section 6.0 of this report.

The concluding remarks and a list of references are included in Sections 7.0 and 8.0, respectively.

3.0 EVALUATION CRITERIA

3.1 Performance Criteria

The as-built NMSF building shall be evaluated in accordance with the guidelines of DOE Standard 1020-94. On the basis of the use foreseen for this structure, Performance Category 3 is applicable to the existing Structures, Systems, and Components (SSC).

The performance goals for this Category 3 structure during and after occurrence of a postulated earthquake event include:

- Occupant safety,
- Continued operation, and
- Confinement of hazardous material.

Quantitatively, this performance requirement corresponds to a Hazard Exceedance Probability of 5×10^{-4} (Return Period of 2000 years).

3.2 Acceptance Criteria

The acceptability of the response of the structural components of the NMSF building is evaluated on a demand-versus-capacity basis. The total demand on structural components consists of non-seismic loads (Dns) such as dead loads, live loads, and seismic loads (Dsi):

$$D_{ti} = D_{si} + D_{ns}$$

where:

D _{ti}	= Total demand
D _{ns}	= Stresses due to non-seismic loads
D _{si}	= Inelastic seismic SF (DS/FU)
D _s	= Elastic seismic demand due to seismic input
F _u	= Inelastic energy absorption factor
	= 1.75 For Shear Wall In-plane Flexure
	= 1.5 For Shear Wall In-plane Shear
	= 1.75 For Shear Wall Out-of-plane Flexure
	= 1.0 For Shear Wall Out-of-plane Shear
SF	= Scale factor = 1.0 for PC-3

These F_u values are the upper limits allowed, and are dependent upon the quality of the detailing that has been used and the consistency of the detailing with the current UBC provisions. Lower numbers shall be used for as-built components that are not in compliance with current detailing practice. An F_u factor of unity was used in this evaluation. This is a conservative assessment, given the lack of documentation and quality assurance for the original design and construction of the NMSF.

The capacity (C_c) of concrete components of the NMSF can be determined based on the ultimate strength provisions of ACI-318 or Chapter 26 of UBC-94(4). The capacity is considered adequate if it exceeds the demand (i.e., the D/C ratio is greater than or equal to one).

3.3 Design Load Cases

In this section, the loading conditions and combinations used for this evaluation are described.

3.3.1 Dead Loads (D)

The dead loads consist of the following components:

Structural Dead Weight:

These loads are estimated based on the geometric dimensions given in the Burns & Roe drawings (14). The following weight densities are used:

Reinforced concrete	:	150 pcf
Steel	:	490 pcf
Backfill soil	:	110 pcf

Equipment Weight:

No specific equipment weight was accounted for in evaluation of the as-built structure.

The proposed modifications to the NMSF building include addition of a 20-ton bridge crane to operate between the first floor walls on lines 1 and 2. The weight and mass of the crane are accounted for in the evaluation of the modified NMSF building.

Future Loads:

An extra 10 psf is assumed on all floors and roofs for future dead loads (1).

Snow Loads:

A minimum of 30 psf is assumed, per specifications of LANL Facility Engineering Standard (1).

3.3.2 Live Loads (L)

250 pounds per square foot of live loads shall be used for all first floor and basement floor areas, per UBC specification for storage areas (4).

3.3.3 Thermal Loads (T_o , T_a)

Thermal loads are not considered in the evaluation of the as-built structure.

The following thermal gradients are used in evaluation of the modified NMSF structure:

Operating condition:

20°F: Across the east and west walls and the charge deck during normal operation (To).

Accident condition:

40°F: Across the east and west walls and the charge deck during postulated accidental loss of cooling system (Ta).

Both conditions:

13°F: Across the basement floor slab during operating as well as accidental conditions (To & Ta).

16°F: Across the 1st floor walls and roof slab during operating as well as accidental conditions (To & Ta).

The specified thermal load criteria were based on preliminary estimates provided by LANL staff (17). The thermal criteria are believed to be conservative because they were based on a highly unlikely accident scenario: the cooling air flow to the facility is assumed to be completely stopped for a period of one year.

3.3.4 Lateral Soil Pressure Loads (Hs,Hd)

Lateral soil pressures are computed using the following properties for the backfill material:

Weight Density	:	110 pcf
Angle of internal Friction	:	40 deg.
Surcharge	:	250 psf

The properties are estimated on the basis of information provided in references (6) and (21).

Due to lack of sufficient geotechnical information, and in lieu of sophisticated SSI analysis, the distribution of the lateral soil pressures on the NMSF walls is estimated using different conservative pressure distribution patterns.

For static pressure, two patterns are used:

- 1) A trapezoidal distribution as suggested by Dames & Moore for NMSF site material (5); and
- 2) A standard triangular distribution typically used for granular backfill.

For dynamic soil pressure distribution, two load patterns are used:

- 1) A uniform distribution as recommended in references (6) and (7); and
- 2) An inverted triangular distribution as suggested by ASCE 4-86 (8).

As a result, a total of four different combinations of the static and dynamic lateral soil pressure loads are used to evaluate the out-of-plane response of NMSF's perimeter walls to dynamic lateral soil pressure.

3.3.5 Wind Loads (W)

The structure is partially buried. Due to its limited exposure area and its low height, wind loads are ignored in the evaluation. Wind loads will be considered at the Title Design stage.

3.3.6 Seismic Loads (E)

The seismic loads used in this evaluation are based on the recommendations of reference (1) and recent seismic hazard evaluation work by Woodward Clyde as follows:

Peak Ground Acceleration (PGA): 0.30 g

Response Spectral Shape: US NRC Regulatory Guide 1.60 spectra shape. (A plot of the seismic spectrum is shown in Figure 3.1.)

The seismic hazard study for the general area around the NMSF building site, being completed by Woodward Clyde, was not available in time for use in the current evaluation.

The February 1975 Woodward Clyde Seismic Hazard Evaluation Report for LANL shows (Figure 10-19) the recommended DBE horizontal response spectra for a 2000-year return period. The US NRC Reg. Guide 1.60 spectral shape resembles the new Woodward Clyde recommended spectral shape better than the original (1975) NUREG/CR-0098 spectral shape. Also, it has been the experience of the project team at other sites that the 1975 NUREG/CR-0098 spectral shape does not hold up as well to regulatory review.

In view of the above, LANL and the project team have agreed on the use of the Reg. Guide 1.60 spectra at this time.

The February 1975 Woodward Clyde Seismic Hazard Evaluation Report for LANL shows (Figure 8-55) the recommended vertical to horizontal spectral ratio as ranging from 1.6 to 0.55. Some controversy continues to cloud this issue. Some of Woodward Clyde's work shows the possibility of ratios as high as 2.0 for high frequencies at near-source sites. Other experts consider the vertical effects to be non-concurrent with the horizontal and of limited duration. A sequencing effect might mitigate the impact of the vertical input motion, and a more standard 2/3 of the horizontal might be applicable.

A simplified vertical evaluation using a vertical to horizontal spectral ratio of 1.0 has been included in the calculations. The report has been enhanced accordingly.

3.4 Load Combinations

The NMSF building is evaluated for the following load combinations:

Seismic load combinations per DOE Standard 1020-94 (three orthogonal components of ground motion are considered):

- 1) $D + L + H_s + H_d + T_o + E$
- 2) $D + L + H_s + H_d + T_o - E$

Non-seismic load combinations:

$$3) \quad 1.4D + 1.7L + 1.7H_s + 1.4 T_a$$

The thermal loads (T_o, T_a) were not considered in evaluation of the as-built structure (the current structure is being used as office space).

3.5 Material Properties

The following properties are used to compute the strength and stiffness properties of the structural components of the NMSF building:

Concrete:

Compressive strength	$f_c = 4,000 \text{ psi}$
Poisson's ratio	$\nu_c = 0.17$

Steel:

Reinforcing steel, ASTM A615, Grade 60	$f_y = 60 \text{ ksi}$
Structural Steel, ASTM A36	$f_y = 36 \text{ ksi}$
Welding	E7018
Modulus of elasticity, E_s	$E_s = 29,500 \text{ ksi}$
Poisson's ratio	$\nu_s = 0.25$

Reference (18) provides some insight into the as-is condition of the structure. The tested concrete strength ranges from 5,780 to 9,070 psi. The concrete cover over the reinforcing steel varied with an average of 3.6 inches.

3.6 Damping

DOE Standard 1020-94 (2) specifies structural damping ratios corresponding to the level of structural response expected to occur during the postulated earthquake event. For a Performance Category 3 reinforced concrete structure such as the NMSF building, the guidelines allow a damping ratio of up to 10% of critical damping if stresses are high enough. A damping ratio of 7% was used in this evaluation; this might result in some conservatism. At the Title Design stage, analysis iterations should be performed to match the damping value used to the stress level obtained for the structure.

4.0 STRUCTURAL EVALUATION OF AS-BUILT STRUCTURE

4.1 Description of NMSF Structure

The existing NMSF building is a cast-in-place concrete shear wall structure which is partially embedded in the ground. The western portion of the building, referred to as the MAA/Storage area, is a two-story structure with its basement floor completely embedded in the ground. The second story of the western portion (from the first floor to the roof) is completely backfilled with soil on the north, west, and south sides of the building. The eastern portion of the NMSF building, constructed on the finished grade, provides space for administrative functions, a mechanical equipment room, and safe, secure transport (SST) garage space. The continuous first floor slab, roof, and shear walls in the east-west direction join the eastern and western portions of the NMSF building together with no construction joint in between. The basic geometric characteristics of the as-built NMSF building are shown in Figure 4.1.

4.2 Modeling Approach

The NMSF building is categorized as a Performance Category 3 structure. Therefore, it is required (2) that a dynamic analysis be performed for seismic evaluation. Additionally, considering the geometrical irregularities and the embedment of a significant portion of the building in the ground, a simplified three-dimensional finite-element model, including only the major structural elements, was developed. The model incorporates rigid diaphragms to simplify the evaluation for the effects of accidental torsion and soil-structure interaction. The out-of-plane response of the typical exterior wall sections of the embedded portion of the NMSF building to the seismically-induced dynamic soil pressure was also analyzed using a separate two-dimensional model.

The vertical analyses for static and dynamic loads were also performed using simplified two-dimensional models.

4.3 Analysis Procedure

In order to ascertain the basic behavior of the structure and help focus the analysis, very simplistic evaluations were initially performed. The understanding of the structure gained in the initial evaluations helped develop subsequent models that addressed areas of structural concern.

4.3.1 Two-Dimensional Analysis of Exterior Walls

The objective of the two-dimensional analysis of the exterior walls was to perform a preliminary investigation of the performance of these walls under static and dynamic lateral soil pressures alone. A one-foot slice of a typical wall section was selected and analyzed using the SAP-90 program. The lateral loads consisted of static as well as dynamic pressures. A more detailed description of the soil pressure loads and their assumed distribution along the height of the walls is provided in Section 3 of this report.

Results from the analysis indicated that the walls in general are capable of withstanding the out-of-plane applied loads.

The results from the two-dimensional analysis are mostly superseded by the more accurate results from the three-dimensional analysis. For details on the procedure and results of the two-dimensional analysis, refer to the calculations (12).

4.3.2 Fixed-Base Analysis

The objective of this analysis was to study the dynamic characteristics of the building without consideration of the embedment effects of the surrounding soil. A three-dimensional finite-element model of the NMSF building was developed using the SAP90 (10) computer program. The exterior walls, major interior walls, roof, and slabs of the building were idealized using the shell elements of SAP90. The computer-generated plots of the finite element model are presented in Figures 4.2 to 4.4.

An eigen-analysis of the fixed base three-dimensional model of the NMSF, described above, was performed to extract the natural frequencies and mode shapes of the building. The results of this analysis are summarized in Table 4.1. The fundamental frequency of the fixed base structure was found to be 13.4 Hertz.

4.3.3 Soil-Structure Interaction (SSI) Effects

To account for SSI effects, the fixed-base three-dimensional model of the NMSF building was revised by adding foundation impedances for three translational and three rotational (two rocking and torsion) degrees of freedom. The foundation impedance for each degree of freedom typically consists of a pair of springs and dashpots representing the stiffness and the damping characteristics of the soil medium respectively. In this evaluation, only the soil springs (no dashpots) were utilized in the model to account for the SSI effects on the natural frequency shift of the building. No time-history analyses were performed in this simplified evaluation. The procedures recommended in reference (8) were used to develop the SSI model.

To account for embedment effects, the soil-springs constants were calculated separately for the western and eastern portions of the NMSF building. The embedment effects of the western portion of the building were accounted for using approximate methods given in reference (11). The embedment above the first floor was neglected, conservatively, to account for potential loss of lateral support during an earthquake (8). The stiffness values used to represent the foundation impedances in the SSI model are summarized in Table 4.2.

A frequency analysis of the SSI model was performed to compute the modal properties of the complete soil-structure model. The results of this analysis are summarized in Table 4.3. The fundamental natural frequency of the SSI model was 11.4 Hz, indicating a frequency shift of about 2.6 Hertz from the fixed-base frequency of 14.0 Hz due to the additional flexibility provided by soil-foundation springs.

It should be noted that SSI analyses in full conformance with current DOE requirements are to be performed for best-estimate, upper-bound, and lower-bound soil properties. In the current conceptual design effort, only best-estimate soil properties are used. Title Design should address the full range of soil properties.

4.3.4 Accidental Torsion Effects

Analysis for accidental torsion was performed by modifying the three-dimensional finite-element model of the NMSF building used in the SSI analysis. The floor mass, mass moments of inertia, and center-of-mass coordinates were first computed for the basement floor, first floor, and roof. The computed masses were then located away from the calculated center of mass so that the resulting eccentricity between the centers of mass and rigidity was effectively increased by 5% of the corresponding floor dimension. Arbitrarily rigid and massless beams were used to connect the lumped floor mass to the wall top nodes

to simulate rigid diaphragms for all floors and the roof. Care was exercised to ensure that the numerical stability of the model was not compromised by the artificially "rigid" beams.

A frequency analysis of this model was performed to study the effects of accidental torsion on the building response. Table 4.4 summarizes the results of the frequency analysis. A comparison of Tables 4.3 and 4.4 shows that a 5% eccentricity of floor mass has a minimal impact on the dynamic characteristics and response of the building. The computer-generated plots of the fundamental natural modes resulting from this analysis are shown in Figures 4.5 through 4.7.

This model was used to carry out the seismic evaluation of the NMSF building subjected to the postulated earthquake. A response spectra analysis was performed using a simultaneous application of the seismic spectra in north/south, east/west, and vertical directions. The PGA of the vertical component of the earthquake was set to 2/3 and to 100% of the horizontal for the analysis of modified structure No. 1 and modified structure No. 2, respectively.

4.4 Structural Evaluation

The response spectrum analysis results were combined with those due to dead loads, live loads, and lateral soil pressure to obtain the total demand on the structure for the load combinations described in Section 3.4. The capacity of the walls was computed in accordance with the provisions of Chapter 26 of the UBC Code (4).

The summary demand/capacity ratios for in-plane and out-of-plane response of the walls of the NMSF building are summarized in Tables 4.5 and 4.6, respectively. The resulting D/C ratios are below the allowable limits.

The computed in-plane shear demand on the shear walls of the NMSF was used to conservatively evaluate the in-plane shear response of the roof and floor slabs. It was assumed that the shear stress is uniformly distributed along the length of the shear walls. This assumption is deemed reasonable, based on an effective length equal to 80% of the actual length of the walls. The computed shear per unit length of walls was compared with the shear capacity of the adjoining roof or floor slab. The maximum shear demand computed for the entire NMSF building was 18.1 kips/F.L. The capacity of the 12" thick concrete slab is conservatively estimated to be 18.2 k/L.F.

It is therefore concluded that there is adequate margin for safety against in-plane shear failure in the 12" concrete slab of the MAA roof and the concrete floor slabs.

The evaluation of the vertical response and resulting out-of-plane demand on roof slabs and floor slabs was accomplished using a 2-D model of a east-west strip of the building. This model and resulting data are explained in further detail in Section 5.

The simplified conservative methods used in the current preliminary structural seismic evaluation are consistent with the conceptual design stage of the structural modifications to the existing NMSF building. A significantly more detailed and complete analysis and evaluation is required for full compliance with current DOE requirements. Detailed analysis is expected to take place at the Title Design stage for the NMSF facility.

The results of this preliminary evaluation indicate that the as-built NMSF building structure could be shown to be adequate to withstand the loads specified by current DOE standards for Performance Category 3 structures.

5.0 STRUCTURAL EVALUATION OF THE MODIFIED STRUCTURE

During this conceptual design effort, the change in function postulated for the structure resulted in a new physical configuration.

The new physical configuration developed as a result of airflow, shielding, criticality, security access, and operational requirements. The structural considerations had to accommodate evolving requirements that were given greater priority. The physical configuration evolved in a continuous manner and two modified conditions (No. 1 and No. 2) are reported in detail.

5.1 Description of Structural Modifications

5.1.1 Modified Structure No. 1

The proposed modifications to the as-built structure of the NMSF facility include the following major items:

- 1) The first floor slab between lines 1 and 3 is removed.
- 2) A new 30-inch-thick charge deck is added at about 3 feet below the existing first floor level between lines 1 and 2.
- 3) The north/south wall on line 1.5 in the basement is removed.
- 4) The existing mezzanine slab between lines B and C is removed.
- 5) A new mezzanine floor slab is added at 10 feet above the basement slab between lines 2 and 3.
- 6) New concrete and concrete-block walls are introduced in the administrative area. The attached calculation in Section 8.4 addresses these walls. Care should be exercised in the detailing of these walls. The new walls should be restrained laterally at top and bottom. The lateral restraint at the top should allow for relative vertical displacement between the top of the walls or partitions, and the roof and supporting precast beams.

This modified configuration is based on references (15) and (16). Modified structure No. 1 was extensively investigated, and is reported in Tables 4.7 to 4.9 and in Figures 4.11 to 4.19.

The analysis results indicated potential vulnerabilities to the structure because of the increased vertical span of the west wall, the new crane loads, and the conservatively estimated thermal loads.

At a late stage in the project, additional shielding requirements resulted in the incorporation of additional walls. Although additional walls would increase the structural margins of safety for the structure, it was deemed appropriate to revise the mathematical model and develop a model for Modified Structure No. 2.

5.1.2 Modified Structure No. 2

The analysis for Modified Structure No. 2 has a confirmatory value because the new modifications considered for the most part increase available structural margins.

This modified configuration is based on reference (25) and is reported in Tables 4.10 to 4.14 and Figures 4.20 to 4.24.

The model for Modified Structure No. 2 included the following:

- 8) Two additional 1.5-ft-thick walls were added in a north/south direction between the basement floor and the charge deck. These walls (15) were included in the three-dimensional SAP90 (10) model. The impact of these additional walls is an increase in the rigidity and strength of the lateral load-resisting system of the NMSF building in the north-south direction. These new walls are included and accounted for in the two-dimensional thermal analysis presented in Section 5.2.3 of this report, and the 2-D models for vertical and horizontal analysis reported in 5.2.4.
- 9) A lightweight mechanical penthouse structure is introduced over the southeast corner of the facility. This penthouse will house unclassified, non-safety mechanical equipment.
- 10) Steel grating is being added to protect the intake vent (26 k) and the stack outlet vent (26 k). These vents will have to be adequately supported in order not to compromise the safety of the NMSF facility.
- 11) Buttresses are introduced to strengthen the west wall in the modified structure. The west wall (line 1) in the modified structure requires strengthening because the vertical span above the charge deck increased by 3 feet. This west wall in the modified structure also supports a new crane and accessory rail, and new thermal loads.
- 12) At the time of this effort, consideration was being given to the potential need to upgrade the NMSF roof over the administrative area for security reasons. In order to harden the roof and prevent or delay penetration by an explosive device, it might become necessary to increase the roof thickness to 8 inches. The capacity of the existing roof precast beams to withstand an additional load appears to be limited. The actual additional thickness requirements are not clear at this time. If substantial slab thickening is required, it could be accommodated by:
 - 1) introducing intermediate beams between the existing T beams,
 - 2) using the current roof slab as part of the formwork system for the facility, and, after removing the existing concrete topping, casting a thicker roof slab that would effectively increase the moment arm for the existing post-tensioning tendons and consequently increase the moment capacity of the existing precast beams, and
 - 3) providing for shear transfer between the old and the added concrete slab by means of closely spaced studs.

5.2 Analysis Procedure

In order to ascertain the basic behavior of the structure and help focus the analysis effort, very simplistic evaluations were initially performed. The understanding of the structure gained in the initial evaluations helped develop subsequent models that addressed areas of structural concern.

5.2.1 Two-Dimensional Analysis of Perimeter Walls

The objective of the two-dimensional analysis of the exterior walls was to provide a preliminary investigation of the performance of these walls due to static and dynamic lateral soil pressures alone. A one-foot slice of a typical wall section was selected and analyzed using the SAP-90 program. The lateral loads consisted of static as well as dynamic pressures. A more detailed description of the soil pressure loads and their assumed distribution along the height of the walls is provided in Section 3 of this report.

The results from this analysis indicate that the walls in general are capable of withstanding the applied loads without major modifications, with the exception of the wall on line 1 between the charge deck and the roof. The vertical span of this wall has been increased due to removal of the existing first floor slab. The wall is subjected to new additional stresses from the new bridge crane and from thermal loads which are consistent with the revised function for the facility and were not accounted for in the original design of the wall. The three-dimensional analysis, presented in the next section, was used to generate more realistic estimates for the out-of-plane forces in the walls.

The results from this analysis are mostly superseded by the results from three-dimensional analyses. For more information on the procedure and results of the two-dimensional analyses, refer to the calculations (13).

5.2.2 Three-Dimensional Analysis

The three-dimensional analyses were performed using the three-dimensional SAP90 model. The three-dimensional model of the as-built NMSF structure, described in Section 4.0 of this report, was first modified to reflect the major structural modifications to the NMSF building. Figures 4.11, 4.12, and 4.13 depict the finite element model of the modified structure. The less important changes to interior walls and equipment are not accounted for at this point.

The modified NMSF model (NMSF05) was then analyzed to extract natural frequencies and mode shapes of the NMSF structure at its modified configuration. The result of the frequency analysis is summarized in Table 4.7. A comparison of the contents of Tables 4.4 and 4.7 indicates that the proposed modifications have increased the stiffness of the structure, resulting in higher natural frequencies. Plots of the fundamental mode shapes of the modified structure are shown in Figures 4.14 through 4.19.

Similar to the analysis of the as-built structure described in Section 4.0, the modified structure was subjected to the combined effects of dead loads, live loads, lateral soil pressure, and earthquake loads as described in Sections 3.0 and 4.0 of this report.

The modified NMSF model No. 2 (NMSF06) provides some confirmatory analyses reported in Tables 4.10 and 4.11.

Additional information regarding vertical amplified response of the structure and horizontal load path across the wall along line 2 is provided by developing a 2-D model reported in Section 5.2.4.

For a detailed description of the analysis results, refer to the supporting engineering calculations (13).

5.2.3 Thermal Stress Analysis

A simplified preliminary analysis was performed to account for the stresses due to the thermal gradients across the walls and slabs surrounding the nuclear material storage area located in the basement of the NMSF building. The thermal load criteria are described in Section 3.3.3.

A two-dimensional east/west slice of the building was modeled for this analysis using the SAP-90 program. The out-of-plane moments and shear forces resulting from thermal analysis were combined with those from three-dimensional analysis to arrive at the total demand on the walls affected by thermal loads. The forces due to thermal loads appear to be very severe for the walls surrounding the storage area, and as such control the design of these elements. A more accurate and less conservative estimate of the thermal gradients through the concrete walls and slabs surrounding the stored nuclear material needs to be developed at the Title Design stage. Realistic accident scenarios need to be considered.

For a more detailed description of the thermal analysis procedure and results, refer to the supporting engineering calculations (13).

5.2.4 Two-Dimensional Analysis of Modified Structure No. 2

The resulting configuration for the modified NMSF results in a very adequate structure in the north-south direction. There is a positive load path and a substantial number of shear walls in the north-south direction. The east-west direction of the structure is not as adequately configured. There is a limited number of east-west shear walls, and the charge deck loads do not have a direct path to the east-west shear walls. Openings required for cooling air flow cannot be disrupted with shear wall elements because of potential air stagnation problems. Furthermore, operational considerations prevent the introduction of north-south shear walls immediately east of the charge deck.

The increased local demands on the west wall because of increased vertical spans, crane loads, and thermal loads are resolved by the introduction of buttresses as shown in Table 4.11. The wall along line no. 2 has to provide a horizontal load path between the charge deck and the slab between lines 2 and 3 at the original first floor level.

In order to better determine the out-of-plane demand on the line 2 wall, a 2-D strip model (Figure 4.24) was developed. This is a very conservative model for the purposes of calculating the out-of-plane demand for the wall on line 2 because it neglects all shear walls perpendicular to this line.

The north-south walls act as beams in the out-of-plane direction. This model provides an upper bound estimate for the out-of-plane demand on the wall on line 2.

This 2-D model was also used for a cursory vertical analyses of the as-built as well as the modified structure.

For a more detailed description of the 2-D model of modified structure No. 2, and the results of the analysis, refer to the supporting engineering calculations (13).

5.3 Structural Evaluation Results

The response spectrum analysis results were combined with those due to dead loads, live loads, and lateral soil pressure to obtain the total demand on the structure for the load combinations described in Section 3.4. The capacity of the walls was computed using the ultimate capacity provisions of Chapter 26 of the UBC (4).

A summary of the Demand and Capacity (D/C) ratios for in-plane shear of the major walls is presented in Table 4.8. Results show that the D/C ratios for the modified structure are all within allowable limits. Based on the field test results for the compressive strength of the concrete in the NMSF building (18), the actual margin of safety is significantly higher than that tabulated.

The summary of the D/C ratios for out-of-plane response of major walls is presented in Table 4.9. Only the walls that are subjected to significant out-of-plane loads are analyzed using the computer model. The secondary interior walls are checked for adequacy using hand calculations. The results show that the D/C ratios for the walls in the modified structure are all within acceptable limits without need for additional strengthening, with the exception of the wall on line 1 (west wall). The new wall added between the existing columns on line 2 can easily be designed to meet the new demands. The existing wall on line 1, however, does not have sufficient strength to withstand the new additional crane and thermal loads and added lateral loads because the vertical span of the wall is also increased by 3 feet. Strengthening of this wall can be accomplished by introducing exterior buttresses.

A retrofit concept using buttresses is provided in the ICF KE engineering calculation supporting this report (13). It should be noted that, although the proposed retrofit scheme was not evaluated for the full extent of the design load combinations required by applicable codes, it is believed to be adequate, qualitatively. More refined solution designs are expected during the Title Design stage.

It should be noted that refined SSI analyses and realistic thermal analyses may possibly help minimize the strengthening requirements for this wall.

The summary of the Demand/Capacity (D/C) ratios for confirmatory in-plane shear for modified structure No. 2 (3-D model) is provided in Table 4-10.

The summary of the Demand/Capacity (D/C) ratios for out-of-plane response of floors and roofs is presented in Table 4.11. This table, when compared with Table 4.9, shows the localized relief provided by the buttresses.

There are extraordinary demands in the out-of-plane direction for the wall along line 2. (See the results of the conservative 2-D model in Table 4.12). It is expected that refined analysis at the Title Design stage will show a reduced demand. In any event, the conservative demand estimated at this point (almost $4\sqrt{f'_c}$) requires that the line along line 2 be detailed as a beam with shear reinforcement in the out-of-plane direction.

The vertical analysis is performed using a simplified 2-D strip model. This simplified approach is conservative in that it ignores the two-way slab action that is likely to further increase the slab capacity, especially in the vicinity of the east-west walls. Results are provided in Table 4.13.

6.0 EVALUATION OF NMSF/TUNNEL INTERACTION

The existing NMSF structure is connected to three tunnels at the lowest elevation (el. 7281). These below-grade connections were examined to determine whether their behavior during a seismic event would be acceptable.

During a seismic event, the tunnels, being fully embedded in soil and much lighter than the NMSF structure, will tend to ride with the soil and be subjected to stresses consistent with seismic soil strains. The NMSF structure, being significantly larger, more rigid, and only partially buried, will interact with the soil and deform in a manner consistent with the resulting soil-structure interaction. The difference in behavior between the NMSF structure and the tunnels would result in seismically-induced stresses at the interface.

A site inspection was performed, and structural drawings were reviewed to determine whether a flexible connection, or at least a construction joint, was introduced at the interface during original design and construction. It was determined that the existing connection was designed and constructed monolithically.

A simplified conservative evaluation was performed and is provided in Section 8.3 of the attached calculations. The methodology used is provided in references (19) and (20). Soil strains introduced in the tunnel and differential seismic anchor movement effects were conservatively estimated and calculated, and the resulting concrete strains were obtained.

The simplified evaluation performed indicates that the tunnel-structure connections will undergo moderate tensile concrete cracking but no compressive crushing. Steel reinforcement will remain below yield. These results indicate that there is no collapse potential for the tunnels and their connection to the structure. It should, however, be noted that the tensile cracking expected could contribute to air and moisture infiltration in the tunnels, as they are envisioned to be maintained at a constant negative pressure.

Consideration should be made of impact to operations and HVAC system demands if tensile cracking and air and moisture infiltration take place during a seismic event. If the facility operating conditions allow it, repair of tensile concrete cracks is not a significant construction effort.

7.0 CONCLUDING REMARKS AND RECOMMENDATIONS

7.1 Existing Facility

The simplified conservative methods used in the current preliminary structural seismic evaluation are consistent with the conceptual design stage of the structural modifications to the existing NMSF building. A significantly more detailed and complete analysis and evaluation is required for full compliance with current DOE requirements. Detailed analysis is expected to take place at the Title Design stage for the NMSF facility.

The results of this preliminary evaluation indicate that the as-built NMSF building structure could be shown to be, in general, adequate to withstand the loads specified by current DOE standards for Performance Category 3 structures, with the exception noted below.

One outstanding weakness of the existing facility is the lack of positive connection between the precast beams and the existing support walls. This deficiency can easily be corrected by providing safety restraints at the connections.

7.2 Modified Facility

The simplified conservative methods used in the current preliminary structural seismic evaluation are consistent with the conceptual design stage of the structural modifications to the existing NMSF building. A significantly more detailed and complete analysis and evaluation is required for full compliance with current DOE requirements. Detailed analysis is expected to take place at the Title Design stage for the NMSF facility.

A summary of the demand and capacity ratios for in-plane shear of the major walls is presented in Table 4.8 and 4.10. Results show that the D/C ratios for the modified structure are all within allowable limits. Based on the field test results for the compressive strength of the concrete in the NMSF building (18), the actual margin of safety is significantly higher than that tabulated.

The summary of the D/C ratios for out-of-plane response of major walls is presented in Table 4.9 and 4.11. Only the walls that are subjected to significant out-of-plane loads are analyzed using the computer model. The secondary interior walls are checked for adequacy using hand calculations.

The north and south exterior walls were evaluated and are reported in Tables 4.5 and 4.6. Please note that these walls do not have to support soil pressures above el. 7302.0'. In the modified structure, the soil bearing against the south wall is removed to provide clearance for air circulation through the new intake grate. Also note that these walls do not have the long unsupported horizontal spans and crane loads that the west wall has.

7.2.1 West Wall

The results show that the D/C ratios for the walls in the modified structure are all within acceptable limits without need for additional strengthening, with the exception of the wall on line 1 (west wall). The new wall added between the existing columns on line 2 can be designed to perform as a beam in the out-of-plane direction to meet the new demands. The existing wall on line 1, however, does not have sufficient strength because:

- 1) the vertical span of the wall has been increased by 3 feet,
- 2) the wall is now supporting a new crane and accessory rail, and
- 3) the new function envisioned for the modified facility results in thermal loads that were not considered in the original design.

Strengthening this wall can be accomplished by adding exterior buttresses.

A retrofit concept is provided in the ICF KE engineering calculation supporting this report (13) (see Section 8.5 of the attached calculations). It should be noted that, although the proposed retrofit scheme was not evaluated for the whole extent of the design load combinations set forth in Section 3.0, it is believed to be qualitatively adequate. More refined solution designs are expected during the Title Design stage.

It should be noted that refined SSI analyses and realistic thermal analyses may possibly help minimize the strengthening requirements for this wall.

7.2.2 Precast Beams

At the time of this effort, consideration was being given to the potential need to upgrade the NMSF roof over the administrative area for security reasons (security concerns apply to the MAA area only). In order to harden the roof and prevent or delay penetration by an explosive device, it might become necessary to increase the roof thickness to 8 inches. The capacity of the existing roof precast beams to withstand an additional load appears to be limited. The actual additional thickness requirements are not clear at this time. If substantial slab thickening is required, it could be accommodated by:

- 1) introducing intermediate beams between the existing T beams,
- 2) using the current roof slab as part of the formwork system for the facility, and, after removing the existing concrete topping, casting a thicker roof slab that would effectively increase the moment arm for the existing post-tensioning tendons and consequently increase the moment capacity of the existing precast beams, and
- 3) providing for shear transfer between the old and the added concrete slab by means of closely spaced studs.

Details are provided in the calculation in Section 8.1, attached.

7.2.3 Tunnel-Structure Connections

The simplified evaluation performed indicates that the tunnel-structure connections will undergo moderate tensile concrete cracking but no compressive crushing. Steel reinforcement will remain below yield. These results indicate that there is no collapse potential for the tunnels and their connection to the structure. It should, however, be noted that the tensile cracking expected could contribute to air and moisture infiltration in the tunnels, as they are envisioned to be maintained at a constant negative pressure. A more realistic evaluation, using 3-D SSI analysis of the tunnel/NMSF structure, will be included in the Title Design stage.

7.2.4 New Interior Walls in the Administrative Area

As shown in the drawings for the modified structure, new concrete and concrete block walls are being introduced in the administrative area. The attached calculation in Section 8.4 addresses these walls. Care should be exercised in the detailing of these walls. The new walls should be restrained laterally at top and bottom. The lateral restraint at the top should allow for relative vertical displacement between the top of the walls or partitions, and the roof and supporting precast beams.

The existing precast beams are likely to be detailed for a moment demand consistent with simply-supported conditions. Any accidental intermediate support could introduce a negative moment overstress.

7.2.5 Penthouse for HVAC Equipment

In the modified structure, it is envisioned that some of the non-safety-related equipment will be placed outside the boundaries of the existing facility because of space limitations.

For the purposes of protecting this equipment from weather, a lightweight steel structure has been conceptualized. Section 8.2 of the attached calculations provides a preliminary design for this enclosure. The calculation also provides a check on the adequacy of the existing structure to support the new penthouse.

7.2.6 Soil-Structure Interaction

In this conceptual design stage, only a simplified SSI evaluation has been performed. To account for SSI effects, the fixed-base, three-dimensional model of the NMSF building was revised by adding foundation impedances for three translational and three rotational (two rocking and torsion) degrees of freedom. The foundation impedance for each degree of freedom typically consists of a pair of springs and dashpots representing the stiffness and the damping characteristics of the soil medium, respectively. In this evaluation only the soil springs (no dashpots) were utilized in the model to account for the SSI effects on the natural frequency shift for the building. No time history analyses were performed in this simplified evaluation. The procedures recommended in reference (8) were used to develop the SSI model.

To account for embedment effects, the soil springs constants were calculated for the western and eastern portions of the NMSF building separately. The embedment effects of the western portion of the building were accounted for using approximate methods given in reference (11). The embedment above the first floor was neglected, conservatively, to account for potential loss of lateral support during an earthquake (8). The stiffness values used to represent the foundation impedances in the SSI model are summarized in Table 4.2.

A frequency analysis of the SSI model was performed to compute modal properties of the complete soil-structure model. The results of this analysis are summarized in Table 4.3. The fundamental natural frequency of the SSI model was 11.4 Hz, indicating a frequency shift of about 2.6 Hz from the fixed base frequency of 14.0 Hz due to the additional flexibility provided by soil foundation springs.

It should be noted that SSI analyses in full conformance with current DOE requirements are to be performed for best-estimate, upper-bound, and lower-bound soil properties. In the current conceptual design effort, only best-estimate soil properties are used. Title Design should address the full range of soil properties.

It is recommended that a site-specific geotechnical investigation be pursued in support of the Title Design effort. The experimental determination of high-strain soil properties should be pursued to avoid potential challenges to the adequacy of the Title Design.

7.2.7 East-West Load Path

The east-west load path is compromised because of the reduced number of east-west shear walls and the openings around the charge deck.

The increased local demands on the west wall because of increased vertical spans, crane loads, and thermal loads are resolved by the introduction of buttresses as shown in Table 4.11. The wall along line 2 has to provide a horizontal load path between the charge deck and the slab between lines 2 and 3 at the original first floor level.

In order to better determine the out-of-plane demand on the line 2 wall, a 2-D strip model (Figure 4.24) was developed. This is a very conservative model for the purposes of calculating the out-of-plane demand for the wall on line 2 because it neglects all shear walls perpendicular to this line.

The north-south walls act as beams in the out-of-plane direction. This model provides an upper bound estimate for the out-of-plane demand on the wall on line 2, and indicates a need to design and detail the wall on line 2 as a beam for out-of-plane shear.

This 2-D model was also used for a cursory vertical analysis of the as-built as well as the modified structure.

For a more detailed description of the 2-D model of modified structure No. 2, and the results, refer to the supporting engineering calculations (13).

7.3 Conservatism

The actual margins of safety for the NMSF building in its as-built and proposed modified configurations could be significantly higher than those obtained from this evaluation. A list of conservative assumptions implicit in this evaluation can be summarized as follows:

- 1) The energy absorption coefficient of F_u was assumed to be equal to 1.0 throughout this evaluation. The allowable F_u values range between 1.0 to 1.75 depending on the quality of construction, per specifications of the DOE-STD-1020-94 (2).
- 2) Structural damping was assumed to be 7% of critical damping. The computed D/C ratios indicate that a higher value may be justified, per the recommendations of reference (2).
- 3) Field test results (18) indicate a much higher compression strength for the concrete (in excess of 7,000 psi) than the value of 4,000 psi used in this evaluation. Also, no credit was taken for the reinforcing steel in computing in-plane shear capacity of the walls. As a result, the margin of safety for the in-plane shear capacity of the walls is significantly higher than those shown in Tables 4.5 and 4.9.
- 4) The dynamic soil pressure on the perimeter walls conservatively overestimates the actual soil pressures. The passive soil pressures generated on the perimeter walls opposing the

ground motion were excluded, resulting in conservative results for the in-plane shear loads on the main shear walls.

- 5) The preliminary thermal loading criteria (Section 3.3.3) is believed to be conservative. Heat transfer analyses performed to obtain thermal gradients across the concrete walls of the material storage area are based on a very conservative accident scenario in which cooling air flow to the facility is completely disrupted for a very extended period of time. Considering the controlling role of the thermal stresses on the total out-of-plane bending demand on these walls, it is important that a more accurate measure of the thermal demands be at hand at the time of Title Design.
- 6) The field tests reported in reference (18) have also determined that the concrete cover over reinforcing steel is greater than that reflected on the design drawings. An increased concrete cover and a reduced moment capacity have been considered in the capacity calculations.
- 7) The shear capacity determination is conservative in that reinforcing was neglected. Higher margins of safety are available and could be demonstrated with further analysis.
- 8) The east-west 2-D model neglects the contribution to lateral strength provided by the east-west walls and buttresses.
- 9) SSI radiation damping has not been taken advantage of.

8.0 REFERENCES

- (1) Los Alamos Facilities Engineering Standards, Volume 5, "Structural Standards Manual," Revision 4, November 1994.
- (2) "Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities," DOE Standard DOE-STD-1020-94, April 1994.
- (3) American Society of Civil Engineers, "Minimum Design Loads for Buildings and Other Structures," ASCE/ANSI Standard 7-93.
- (4) International Congress of Building Officials, "Uniform Building Code" (UBC), 1994 edition.
- (5) Dames & Moore Geotechnical report, 1972. (Most complete title available.)
- (6) EPRI Report NP-6041-SL, Rev 1. (Most complete title available.)
- (7) "Soil Dynamics," by Shamsheer Parkash, McGraw Hill, 1981.
- (8) American Society of Civil Engineers, "ASCE-4-86, Seismic Analysis of Safety-Related Nuclear Structures and Commentary on Standard for Seismic Analysis of Safety Related Nuclear Structures," 1986.
- (9) U. S. Nuclear Regulatory Commission, "Nuclear Regulatory Guide NUREG-0098".
- (10) "A Series of Computer Programs for Static and Dynamic Finite Element Analysis of Structures," SAP90 User's Manual, Computers and Structures, Inc., Berkeley, California.
- (11) "Soil-Structure Interaction in Time Domain," by Wolf.
- (12) "Structural Evaluation of the NMSF at LANL, As-Built Structure," ICF Kaiser Calculation Number 41552-S-0001, rev 0, March 1995.
- (13) "Structural Evaluation of the NMSF at LANL, Modified Structure," ICF Kaiser Calculation Number 41552-S-0002, rev 0, March 1995.
- (14) As-Built Construction Drawings for the Nuclear Materials Storage Facility, prepared by Burns and Roe Pacific, Inc, dated October 18, 1985. As-Built as of July 10, 1985. Lab Job No. 6481-55, LANL Drawing No. C-44952. Specific sheets listed below:

DOE DWG. NO's LA-ZJ-B.A.1 through LA-ZJ-B.A.25 and DOE DWG. NO's LA-ZJ-B.S.1 through LA-ZJ-B.S.11
- (15) ICF Kaiser Preliminary (0%) Architectural Drawings of the Modified NMSF Facility, Sheets A1 through A5, dated Jan. 13, 1995.
- (16) Marked-up Preliminary (0%) ICF Kaiser drawing sheet A2. Transmitted to ICF Kaiser Oakland office on Feb. 12, 1995.

- (17) Notes from Thad Knight of LANL to Pepe Vallenias of ICF Kaiser, dated Feb. 8, 1995.
- (18) "Condition Survey of Nuclear Material Storage Facility, Los Alamos Laboratory, Los Alamos, New Mexico," by Construction Technology Laboratory, Inc., January 1995.
- (19) American Society of Civil Engineers, ASCE Structural Division Committee on Nuclear Structures and Materials, "Seismic Response of Buried Pipes and Structural Components," 1983.
- (20) Atalay M. B. "Seismic Analysis and Design of Buried Piping." Lifeline Earthquake Engineering, Third U.S. Conference, Los Angeles, CA, August 22-23, 1991.
- (21) Goen, L. K., "Soil Structure Interaction Analysis," PF-4-ESA 13-2B-001.
- (22) American Society of Civil Engineers, "ASCE 4-86, Seismic Analysis of Safety Related Structures and Commentary for Seismic Analysis fo Safety Related Structures," 1986.
- (23) Anmerican Concrete Institute, "ACI 349-90, Code Requirements for Nuclear Safety Related Concrete Structures," 1990.
- (24) American Institute of Steel Construction, "AISC N690-84, Specification for the Design, Fabrication, and Erection of Steel-Safety Related Structures for Nuclear Facilities," 1984.
- (25) ICF Kaiser 100% Draft Architectural Drawings of the Modified NMSF Facility, Sheets A1-A5, May 1995.

TABLE 4.1 FREQUENCY ANALYSIS, FIXED BASE MODEL, AS-BUILT STRUCTURE (NMSF0)

Mode	Frequency Hz	X-Direction Mass Percent	Y-Direction Mass Percent	Z-Direction Mass Percent
1	14.0	73.3	0.0	0.0
2	15.7	73.3	1.1	0.0
3	17.4	73.6	1.2	0.0
4	17.8	73.7	1.2	0.0
5	19.4	73.7	71.7	0.0
6	25.8	78.8	71.8	0.0
7	31.2	80.8	80.7	0.2
8	33.2	81.1	81.9	2.5
9	36.2	92.5	83.9	2.6

TABLE 4.2 FOUNDATION SOIL SPRING CONSTANTS (Units: Kips,Ft)

Foundation	Kx (*)	Ky	Kz	Kxx	Kyy	Kzz
Basement (lines 1 to 3)	259G (**)	272G	340G	3.67E5G	2.15E6G	1.15E6G
1st Floor (line 3 to 8)	317G	300G	214G	2.53E6G	1.25E6G	1.60E7G

Notes:

(*) - Coordinate System: X-dir East/West
 Y-dir North/South
 Z-dir Vertical

(**) - $G=6.1E3$ Kips/SF (Best Estimate Soil Shear Modulus)

**TABLE 4.3 FREQUENCY ANALYSIS, FIXED BASE MODEL WITH SOIL SPRINGS, AS-BUILT
STRUCTURE (NMSF01)**

Mode	Frequency Hz	X-Direction Mass Percent	Y-Direction Mass Percent	Z-Direction Mass Percent
1	11.4	92.3	0.2	0.2
2	11.7	92.6	87.8	0.3
3	14.9	92.9	87.9	98.6
4	16.4	92.9	88.0	98.7
5	17.4	93.0	88.2	98.8
6	18.0	93.0	96.7	98.9
7	23.2	96.3	96.7	99.0
8	23.7	96.3	98.8	99.0
9	28.0	96.9	98.8	99.9

TABLE 4.4 **FREQUENCY ANALYSIS, SSI MODEL WITH MASS ECCENTRICITY FOR
ACCIDENTAL TORSION, AS-BUILT STRUCTURE (NMSF04)**

Mode	Frequency Hz	X-Direction Mass Percent	Y-Direction Mass Percent	Z-Direction Mass Percent
1	11.7	93.4	0	0
2	11.8	94.0	92.8	1
3	12.3	94.0	93.8	99.7
4	17.7	94.0	98.7	99.9
5	21.1	97.8	98.8	99.9
6	26.5	99.1	98.8	99.9
7	28.7	99.7	98.8	99.9
8	36.8	99.7	100	99.9
9	41.5	100	100	99.9

TABLE 4.5 SUMMARY OF WALL IN-PLANE SHEAR DEMAND/CAPACITY RATIOS FOR AS-BUILT STRUCTURE

Wall ID	Shear Demand (Kips)	Shear Capacity (Kips)	Shear D/C	Wall Location
3	822	2763	.30	Line 1 Basement
6	868	2671	.33	Line 3 Basement
8	167	434	.38	Line 5 Basement
9	1216	1239	.98	Line B Basement
12	788	1022	.77	Line G Basement
4	485	1594	.30	Line 1+ Basement
5	432	1310	.33	Line 2 Basement
1	84	284	.30	Line 2 Basement
10	189	235	.80	Line C Basement
11	264	358	.74	Line F Basement
19	1477	2450	.60	Line 1 1st Floor
34	692	881	.79	Line G 1st Floor
27	695	1006	.69	Line B 1st Floor
21	1333	1638	.81	Line 3 1st Floor
20	222	377	.59	Line 2 1st Floor
29	325	364	.89	Line C 1st Floor
28	758	991	.76	Line B 1st Floor
25	996	1367	.73	Line 7 1st Floor
35	736	966	.76	Line G 1st Floor
38	745	991	.75	Line A 1st Floor
32	253	358	.71	Line F 1st Floor

TABLE 4.6 SUMMARY OF WALL OUT-OF-PLANE SHEAR AND BENDING DEMAND/CAPACITY RATIOS FOR AS-BUILT STRUCTURE

Wall ID	Shear Demand (Kips)	Shear Capacity (Kips)	SHR D/C	Moment Demand (k-ft)	Moment Capacity (k-ft)	MOM D/C	Wall Location
3	17.5	21.3	.82	(+)55.0 (-)30.1	108 116	.51 .26	West Wall Basement
19	14.9	18.7	.80	(+)32.3 (-)16.9	60 26	.54 .65	West Wall 1st Floor
12	17.5	21.3	.82	(+)5.2 (-)3.0	78 232	.07 .01	South Wall Basement
34	14.9	19	.78	(+)5.2 (-)3.0	78 232	.07 .01	South Wall 1st Floor
9	17.5	21.3	.82	(+)13.6 (-)11.4	78 232	.17 .05	North Wall Basement
27	14.9	19	.78	(+)16.5 (-)31.5	42 24	.39 1.31	North Wall 1st Floor
Others	n/a	n/a	n/a	(+)5.2 (-)6.9			All Other Walls Mostly Interior Walls, O.K. By Inspection

TABLE 4.7 **FREQUENCY ANALYSIS, SSI MODEL WITH MASS ECCENTRICITY FOR
ACCIDENTAL TORSION, MODIFIED STRUCTURE (NMSF05)**

Mode	Frequency (Hz)	X-Direction Mass (Percent)	Y-Direction Mass (Percent)	Z-Direction Mass (Percent)
1	9.9	80.6	0.2	16.4
2	10.0	80.8	91.9	20.9
3	10.2	97.6	96.4	99.2
4	15.3	97.6	99.5	99.4
5	18.1	97.6	99.6	99.4
6	19.4	99.0	99.6	99.9
7	25.8	99.9	99.6	99.9
8	31.6	100.	99.6	99.9
9	40.5	100.	99.9	99.9

TABLE 4.8 SUMMARY OF WALL IN-PLANE SHEAR DEMAND/CAPACITY RATIOS FOR MODIFIED STRUCTURE NO. 1

Wall ID	Shear Demand (Kips)	Shear Capacity (Kips)	Shear D/C	Wall Location
1	1629	4847	0.34	Basement-line 1
2	131	339	0.39	Basement-line 1
4	124	301	0.41	Basement-line 2
5	1770	2424	0.73	Basement-line 2
6	1080	2671	0.40	Basement-line 3
9	1315	1239	1.06	Basement-line B
12	837	994	0.84	Basement-line G
8	215	550	0.39	Basement-line 4
10	230	235	0.98	Basement-line D
3	70	550	0.13	Basement - S. Baffle
33	279	296	0.94	Basement- line F
11	227	296	0.77	Basement-line C
7	274	550	0.50	Basement- N. Baffle
29	250	279	0.90	Buttress
21	1072	2302	0.47	1st flr-line 3
28	791	991	0.80	1st flr-line B
30	578	812	0.71	1st flr-line E
35	751	996	0.78	1st flr-line G
18	509	550	0.93	Basement-line F
36	114	158	0.72	1st flr-line C
25	826	1371	0.60	1st flr-line 7
38	721	991	0.73	1st flr-line A

TABLE 4.9 SUMMARY OF WALL OUT-OF-PLANE SHEAR AND BENDING DEMAND/CAPACITY RATIOS FOR MODIFIED STRUCTURE NO. 1

Wall ID	Shear Demand (Kips)	Shear Capacity (Kips)	SHR D/C	Moment Demand (k-ft)	Moment Capacity (k-ft)	MOM D/C	Wall Location	Notes
1	15.4	21.3	0.72	279	356	0.78	Basement line 1	New
5	N/A	N/A	N/A	201	287	0.70	Basement line 2	New
9	15.4	21.3	0.72	44	78	0.56	Basement lines B&G	Existing
19	19.7	18.7	1.07	129	60	2.15	1st-Flr line 1	(1)
16	N/A	N/A	N/A	80	96	0.83	1st-Flr line 2	New
27	19.7	21.3	0.92	26	24	1.08	1st Flr-lines B&G	Existing
Others	negligible	N/A	N/A	10	N/A	negligible	(*)O.K. By Inspection	

NOTES:

- (1) This segment of the west wall is determined to be inadequate at as-built conditions to meet the additional demands due to a large span caused by lowering the first floor slab and addition of the new bridge crane. A conceptual upgrade is provided in the supporting calculations, Section 8.5 (13).

N/A Not Available

**TABLE 4.10 SUMMARY OF WALL IN-PLANE SHEAR DEMAND/CAPACITY RATIOS FOR
MODIFIED STRUCTURE NO. 2, 3-D MODEL**

Wall ID	Shear Demand (Kips)	Shear Capacity (Kips)	Shear D/C	Wall Location
1	1416	4847	0.29	Basement-line 1
2	181	339	0.53	Basement-line 1
4	126	301	0.42	Basement-line 2
5	1705	2424	0.70	Basement-line 2
9	1518	1239	1.24	Basement-line B
12	994	994	0.97	Basement-line G

**TABLE 4.11 SUMMARY OF WALL OUT-OF-PLANE BENDING DEMAND/CAPACITY RATIOS
 FOR MODIFIED STRUCTURE NO. 2, 3-D MODEL**

Wall ID	Moment Demand (k-ft)	Moment Capacity (k-ft)	MOM D/C	Wall Location	Notes
1	281	356	0.79	Basement line 1	New
5	206	287	0.72	Basement line 2	New
9	49	78	0.63	Basement lines B&G	Existing
19	75	60	1.25	1st-Flr line 1	(1) Modify
16	35	96	0.36	1st-Flr line 2	New
27	46	42	1.10	1st Flr-lines B&G	Existing
Others	10	Small	Small	All others	O.K. By Inspection

NOTES:

- (1) This segment of the west wall was determined to be inadequate at as-built conditions to meet the additional demands due to a large span caused by lowering the first floor slab and addition of the new bridge crane. A conceptual upgrade using buttresses is provided in the supporting calculations, Section 8.5 (13), and results in the lowered D/C ratio.

**TABLE 4.12 SUMMARY OF WALL OUT-OF-PLANE SHEAR AND BENDING
 DEMAND/CAPACITY RATIOS FROM HORIZONTAL ANALYSIS OF MODIFIED
 STRUCTURE NO. 2, 2-D MODEL**

Wall ID	Shear Demand (Kips)	Shear Capacity (Kips)	SHR D/C	Moment Demand (k-ft)	Moment Capacity (k-ft)	MOM D/C	Wall Location	Notes
1	5	21.3	0.23	253	356 ³	0.71	Basement line 1	New
5	35	46	0.76	320	356 ³	.90	Basement line 2	New (3)
9	N/A	N/A	N/A	N/A	N/A	N/A	Basement lines B&G	Existing
19	6.6	18.7	0.35	112	60	1.87	1st-Flr line 1	(1) Modify
16	15	18.7	0.80	135	135 ³	1.0	1st-Flr line 2	New (2)
27	N/A	N/A	N/A	N/A	N/A	N/A	1st-Flr lines B&G	Existing

NOTES:

- (1) This segment of the west wall is determined to be inadequate at as-built conditions to meet the additional demands due to a large span caused by lowering the first floor slab and addition of the new bridge crane. A conceptual upgrade is provided in the supporting calculations, Section 8.5 (13).
- (2) The new wall will be designed as a beam out-of-plane with shear reinforcement and shear capacity of $4\sqrt{f'_c}$.
- (3) Preliminary estimate design value.
- N/A Not Available.

**TABLE 4.13 SUMMARY OF VERTICAL ANALYSIS RESULTS
 MODIFIED STRUCTURE NO. 2, 2-D MODEL**

Item	Max Moment (Ft-K)			Max. Shear (Kips)			Notes
	Demand	Capacity	D/C	Demand	Capacity	D/C	
MAA Roof Slab	41.9	43.7	0.96	8.5	12.9	0.66	Existing
1st Floor Slab	30.5	25.3	1.21	7.9	12.9	0.61	Existing
Mezz. Floor Slab	32.9	33.9	.97	8.0	12.9	0.62	New Design
Charge Deck	45.7	540	0.08	10.8	38.7	0.28	New Design
30' Span 18x38 Beams @ MAA Area Roof	1476	1430	1.03	246	187	1.32	Existing (1)
30' Span 18x38 Beams @ MAA Area Roof				122	187	0.65	Existing (2)

NOTES:

- (1) Beam with topside soil in-place.
- (2) Beam O.K. with topside soils removed.

Figure 3 - Horizontal and Vertical Acceleration Response Spectrum

Figure 4.1 - Geometry of As-Built NMSF Building

Figure 4.1 - Geometry of As-Built NMSF Building (Continued)

Figure 4.1 - Geometry of As-Built NMSF Building (Continued)

**Figure 4.2 - NMSF Finite Element Model, Complete Model
 As-Built Structure**

**Figure 4.3 - NMSF Finite Element Model, Basement Walls
 As-Built Structure**

**Figure 4.4 - NMSF Finite Element Model, First Floor Walls
 As-Built Structure**

Figure 4.5 - Fundamental Mode of Vibration No. 1
 As-Built Structure

Figure 4.6 - Fundamental Mode of Vibration No. 2
 As-Built Structure

**Figure 4.7 - Fundamental Mode of Vibration No. 3
 As-Built Structure**

Figure 4.8 - Fundamental Mode of Vibration No. 4
 As-Built Structure

**Figure 4.9 - Fundamental Mode of Vibration No. 5
 As-Built Structure**

Figure 4.10 - Fundamental Mode of Vibration No. 6
 As-Built Structure

**Figure 4.11 - NMSF Finite Element Model, Basement Walls
 Modified Structure No. 1**

**Figure 4.12 - NMSF Finite Element Model, First Floor Walls
Modified Structure No. 1**

Figure 4.13 - Fundamental Mode of Vibration No. 1
 Modified Structure No. 1

Figure 4.14 - Fundamental Mode of Vibration No. 2
 Modified Structure No. 1

**Figure 4.15 - Fundamental Mode of Vibration No. 3
 Modified Structure No. 1**

Figure 4.16 - Fundamental Mode of Vibration No. 4
 Modified Structure No. 1

Figure 4.17 - Fundamental Mode of Vibration No. 5
 Modified Structure No. 1

**Figure 4.18 - Fundamental Mode of Vibration No. 6
 Modified Structure No. 1**

Figure 4.19 - Fundamental Mode of Vibration No. 7
 Modified Structure No. 1

**Figure 4.20 - NMSF Finite Element Model, Basement Walls
 Modified Structure No. 2, 3-D Model**

**Figure 4.21 - NMSF Finite Element Model, First Floor Walls
 Modified Structure No. 2, 3-D Model**

Figure 4.22 - Fundamental Mode of Vibration No. 1
 Modified Structure No. 2, 3-D Model

Figure 4.23 - Fundamental Mode of Vibration No. 2
 Modified Structure No. 2, 3-D Model

Figure 4.24 - NMSF 2-D Finite Element Model,
 Modified Structure No. 2

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STRUCTURAL EVALUATION OF NMSF FACILITY AT LANL

As-Built Structure

DESIGNED BY B. Mosaddad DATE 3/10/95
CHECKED BY *TL* DATE 5/2/95**TABLE OF CONTENTS**

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NOTES :

SEE COMPUTER OUTPUT BINDERS "A" and "B" ASSOCIATED
WITH THIS CALCULATION.

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STRUCTURAL EVALUATION OF NMSF FACILITY AT LANL

As-Built Structure

DESIGNED BY B. Mosaddad DATE 3-10-95

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1.0 INTRODUCTION

The NMSF building consists of a two story storage area and a single story section including mechanical and administration area. The 1st floor of the storage area continues on grade to form the administration building. See figure 1. The basement of the storage building is buried in the soil. The 1st floor walls of the storage area is also completely embedded on east side, north side and south side of the building.

This calculation documents the details of the analysis procedure and structural evaluation of the As-built NMSF building in accordance with the LANL, DOE and associated industry standard design codes (1,2,3,4). For a complete presentation of the evaluation criteria and presentation of the summary of evaluation results refer to the report titled:

Seismic

"Structural Evaluation of the NMSF Building at LANL"

2.0 LIST OF REFERENCES

- (1) Los Alamos Facilities Engineering Standard- Structural, 1993
- (2) "Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities", DOE Standard DOE-STD-1020-94, April 1994.
- (3) "Minimum Design Loads for Buildings and Other Structures", ASCE Standard ASCE-7.-93
- (4) Uniform Building Code (UBC), 1994 edition.
- (5) Dames & Moor Geotechnical report , 1972
- (6) EPRI Report NP-6041-SL Rev 1.
- (7) Soil Dynamics, By Shamsher Parkash
- (8) "Seismic Analysis of Safety-Related Nuclear Structures and Commentary on Standard for Seismic Analysis of Safety Related Nuclear Structures", ASCE Standard ASCE-4-86, September 1986.
- (9) Nuclear Regulatory Guide NUREG-098
- (10) "A Series of Computer Programs for Static and Dynamic Finite Element Analysis of Structures", SAP90 User's Manual, Computers and

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As-Built Structure

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Structures, Inc., Berkeley, California.

- (11) Soil-Structure-Interaction in Time Domain, by Wolf.
- (12) Burns and Roe Drawings

DOE DRG. NO.: LA-ZJ-B.A.1 Through LA-ZJ-B.A.25
and
DOE DRG NO.: LA-ZJ-B.S.1 Through LA-ZJ-B.S.11

NOTE³

A COMPLETE REFERENCE LIST
CAN BE FOUND IN SECTION A OF
PART - PRELIMINARY REPORT.

THE LIST PROVIDED HERE IS
FOR INFORMATION ONLY AND
COMPLETE CITATIONS ARE NOT
PROVIDED

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STRUCTURAL EVALUATION OF NMSF FACILITY AT LANL

As-Built Structure

DESIGNED BY B. Mosaddad DATE 3/10/95
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3.0 SCOPE OF EVALUATION

A three dimensional dynamic analysis of the as-built structure of the NMSF building is performed using Computer program SAP() (10).

The finite element model includes the soil-structure-interaction effects using a lumped mass approach per guidelines of ASCE 4-86(8). The static and dynamic lateral soil pressure on the embedded perimeter walls are included as equivalent static loads in the 3-dimensional model. The accidental torsional effects are accounted for by imposing a deliberate additional 5% eccentricity of floor masses.

Response spectrum analysis is performed using 5% damped ~~NUREG-98~~ acceleration response spectrum applied in three orthogonal directions simultaneously. The magnitude of the vertical components of the earthquake is assumed to be 2/3 of the horizontal component. The peak ground acceleration of 0.3g is used in these analysis. The structural modal damping used in response spectrum analysis is assumed to be equal to 7% of the critical damping. In addition to dynamic loads the NMSF building is also evaluated for UBC code specified static load combinations including dead, live and soil pressure loads.

The Capacity of the structural components of the NMSF Structure is calculated based on ultimate capacity of reinforced concrete structures using provisions of Chapter 26 of UBC (4).

The Engineering drawings of the NMSF building used in this evaluation were those generated by Burns and Roe (12).

JV Reg. No. 1.60 JV
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5/26/95

Calc. No. S-0001, REV 0

JOS No 455-
Sta. 6 of 27-
BM
3/10/95
JUS: 77

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STRUCT. EVALUATION OF NMSF FACILITY
AS-BUILT STRUCTURE

LOS ALAMOS / NMSF FACILITY SEISMIC CRITERIA
DESIGN GROUND ACCELERATION SPECTRUM (PGA=0.3g)

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STRUCTURAL EVALUATION OF NMSF FACILITY AT LANL

DESIGNED BY B. Mosaddad DATE 3/10/95

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4.0 2-DIMENSIONAL ANALYSIS OF EXTERIOR WALLS

The purpose of this analysis was to perform a preliminary evaluation of the exterior walls of the NMSF building that are buried in the ground and backfilled with soil on for sides of the western portion of the building.

In this analysis a 1 foot slice of the walls are modeled using beam elements of Computer program SAP90. The loadings consist of static and dynamic soil pressures. The dynamic soil pressure is estimated using Mononobe-Okabe Formulas from reference provided by reference (6,7,8) using a PGA of equal to 0.3g.

A summary of computed demands and capacities of different walls are tabulated on next page. The results indicate that the exterior walls have adequate strength to withstand the lateral soil pressure caused by the postulated DBE earthquake.

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DATE: 3/10/95

STRUCTURAL EVALUATION OF
NMSE FACILITY AT LANL, AS-BUILT Structure

CHECKED BY:

DATE: 5/2/95

SUMMARY OF DEMAND/CAPACITY RATIO CALCULATIONS(*)

(AS BUILT)

WALL SECTION	UNITS (KIPS, IN)	LC1	LC2	LC3	LC4	CAPACITY	MAX D/C
WEST WALL							
Basement	MOM(+)	642	546	746	606	1296	0.58
	MOM(-)	341	280	352	292	1392	0.25
	SHEAR	14.7	14.3	17.5	14	21.3	0.82
1st Floor	MOM(+)	525	546	409	401	720	0.76
	MOM(-)	200	278	93	162	312	0.89
	SHEAR	13.3	14.9	8.9	10.4	18.7	0.80
EAST WALL							
Basement	MOM(+)	501	485	442	426	648	0.77
	MOM(-)	269	279	209	218	684	0.41
	SHEAR	9.9	8.9	10.3	9.3	21.3	0.48
SOUTH WALL / North Wall							
Basement	MOM(+)	642	546	746	606	2160	0.35
	MOM(-)	341	280	352	292	2784	0.13
	SHEAR	14.7	14.3	17.5	14	21.3	0.82
1st Floor	MOM(+)	525	546	409	401	816	0.67
	MOM(-)	200	278	93	162	288	0.97
	SHEAR	13.3	14.9	8.9	10.4	19	0.78
LC1 = S1 + D1 + I + Q S1: Trapezoidal Static Soil Pressure LC2 = S1 + D2 + I + Q S2: Triangular Static Soil Pressure LC3 = S2 + D1 + I + Q D1: Uniform Dynamic soil Pressure LC4 = S2 + D2 + I + Q D2: Inv. Triangular Dynamic soil Pressure							

(*) Reference SAP90 Runs: WEST31, EAST11

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Evaluation of NMIP @ LANL

AS-BUILT Structure

DESIGNED BY BM DATE 3/10/95

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Capacity Calculations

Use: $f'_c = 4000 \text{ psi}$
 $f_y = 60,000 \text{ psi}$

1) WEST Wall, Basement.

Flexure:

$$\#10 @ 9 \rightarrow A_s = 1.27 \times 12/9 = 1.693 \text{ in}^2$$

$$b = 12''$$

$$d = 18 - 1.5 = 16.5''$$

$$\rho = \frac{1.693}{(12 \times 16.5)} = 0.0086$$

$$a = A_s f_y / 0.85 f'_c b$$

$$= \frac{1.693 \times 60}{0.85 \times 4 \times 12} = 2.49$$

$$\phi = 0.9 \rightarrow$$

$$M_u = 0.90 \times 1.693 \times 60 \left(16.5 - \frac{2.49}{2} \right)$$

$$= 1395 \text{ K-in/L.F.}$$

Shear:

$$V_c = 2 \sqrt{f'_c} \cdot b_w \cdot d$$

$$= 2 \sqrt{4000} \times 12 \times 16.5$$

$$= 25 \text{ Kip/L.F.}$$

$$V_u = 0.85 \times 25 = 21.3 \text{ K}$$

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EVALUATION OF NMCF FAULT AT LANL

As-Built Structure

DESIGNED BY BM

DATE 3/10/92

CHECKED BY SV

DATE 5/5/92

WEST WALL

REF: DOE DRG NO.
LA-ZJ-B.S.B.1

REF: DOE DRG NO.

LA-ZJ-B.S.B.1

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STRUCTURAL EVALUATION OF NMSE FACILITY AT

LANL, As-Built Structure

DESIGNED BY BM

DATE 3/10/95

CHECKED BY TV

DATE 5/2/95

EAST WALL

REF: DOE DRG NO
LA-ZJ-B-S-B.1

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Evaluation of NMSE @ LANL
As-Built

DESIGNED BY BM

DATE 3/10/91

CHECKED BY SL

DATE 5/2/93

SOUTH WALL

REF: DOE DRG NO.
LA-25.B.S.7.1

LANL	DESIGNED BY:	BM	DATE:	3/10/95
Evaluation of NMSF @ LANL	CHECKED BY:	IL	DATE:	5/4/15
As-Built				

SUMMARY OF WALL CAPACITY CALCULATIONS (AS BUILT)

WALL SECTION		UNITS: (KIPS,IN)				CAPACITY U: (K,FT)	Comments
	Rebar	As	d	a			
WEST WALL							
Basement	Mu(+)	#10@9	1.693	15.4	2.49	108	
	Mu(-)	#10@9	1.693	16.5	2.49	116	
	Vc			16.5		21.3	
1st Floor	Mu(+)	#8@9	1.053	13.5	1.55	60	
	Mu(-)	#5@9	0.413	14.5	0.61	26	
	Vc			14.5		18.7	
EAST WALL							
Basement	Mu(+)	#7@9	0.8	15.5	1.18	54	
	Mu(-)	#7@9	0.8	16.5	1.18	57	
	Vc			16.5		21.3	
SOUTH WALL							
Basement	Mu(+)	#10@5	3.048	15.4	4.48	180	@ Bottom half
	Mu(+)	#9@10	1.2	15.4	1.76	78	@ Top half
	Mu(-)	#11@5	3.744	16.5	5.51	232	
	Vc			16.5		21.3	
1st Floor	Mu(+)	#9@10	1.2	13.5	1.76	68	@ Bottom half
	Mu(+)	#7@10	0.72	13.5	1.06	42	@ Top half
	Mu(-)	#5@10	0.372	14.7	0.55	24	
	Vc			14.7		19.0	
f'c=		4 ksi	fy=		60 ksi		
$\text{Mu} = 0.90 \cdot \text{As} \cdot \text{fs} \cdot (d - a/2)/12$ $\text{Vc} = 0.85 \cdot 2 \cdot \text{Sqrt}(f'c) \cdot \text{bw} \cdot d$							

$$\begin{aligned} LC1 &= S1 + D1 + I \\ LC2 &= S1 + D2 + I \\ LC3 &= S2 + D1 + I \\ LC4 &= S2 + D2 + I \end{aligned}$$

Load Combinations:

S1 = Static Pressure (Per D&H Report)
 S2 = Standard Triangular dist. for backfill material
 D1 = Uniform dyn. soil pressure (Mononobe-Okabe)
 D2 = Triangular distribution of dyn. soil pressure (A-0)
 I = Wall Inertia Load

Load Cases:

LOAD CASES / COMBINATIONS

JOB No. 41552 SHEET 14 OF 274	DESIGNED BY K.M. DATE 3/10/95	AS-BUILT
	CHECKED BY J.V. DATE 5/4/15	EVALUATION OF LANE (Calc. 5-0001, Rev. 0)

KAISER ENGINEERS

LANC

STRUCTURAL EVALUATION OF NMSE FACILITY AT LANC

As-Built Structure

DESIGNED BY BM

DATE 3/10/95

CHECKED BY JV

DATE 5/4/96

S1 :

$$S1 = 25 H \quad (\text{REF.})$$

$$= 25 \times 35.88 = 898 \text{ lb/ft} \approx 900 \text{ lb/ft} = \underline{75 \text{ lb/in}}_{\text{East Wall}}$$

$$S1 = 25 \times 21 = 525 \text{ lb/ft} \approx \underline{44 \text{ lb/in}}_{\text{West Wall}}$$

S2 :

$$S2 = \gamma \cdot H \cdot k_a \quad \gamma = 110 \text{ PCF}$$

$$k_a = 0.3 \quad (\text{Conservative})$$

$$S2 = 110 \times 35.88 \times 0.3 = 1184 \text{ lb/ft} \approx \underline{100 \text{ lb/in}}_{\text{W.W.}}$$

$$S2 = 110 \times 21 \times 0.3 = 693 \text{ lb/ft} \approx 58 \text{ lb/in}$$

D1 :~~East~~ wall:
west

$$\text{Total Dyn. Load} = 15,447 \text{ lb}$$

$$D2 = \frac{15,447}{35.88 \times 12} = 36 \text{ lb/in}$$

East
~~West~~ Wall :

$$\text{Total Dyn. Load} = 5457 \text{ lb}$$

$$D2 = \frac{5457}{21 \times 12} = 21 \text{ lb/in}$$

EVALUATION OF NMSE @ LANL
AS-BUILT Structure
LANL

DESIGNED BY BM

DATE 3/10/95

CHECKED BY JL

DATE 5/4/91

D2

This load case is an equivalent Triangular distribution of the dynamic Soil Pressure Loads D1.

$$(East Wall) \quad D2 = 2 \times 36 = 72 \text{ lb/in}$$

$$(West Wall) \quad D2 = 2 \times 21 = 44 \text{ lb/in}$$

I:

Inertial loads are computed for maximum Horizontal acceleration of 0.3g.

$$\gamma = 150 \text{ PCF}$$

Basement Wall:

$$I = \frac{18 \times 12}{(12 \times 12)} \times \frac{150}{12} \times 0.3 = 5.6 \text{ lb/in}$$

1st Floor Wall

$$I = \frac{16 \times 12}{(12 \times 12)} \times \frac{150}{12} \times 0.3 = 5.0 \text{ lb/in}$$

Q:

Surcharge Pressure is assumed to be equal to 250 PSF.

$$Q = 0.3 \times 250 = 6.25 \text{ lb/in}$$

EVALUATION OF NMSF @ LANL

AS-BUILT

LANL

DESIGNED BY BM

DATE 3/10/95

CHECKED BY JV

DATE 1/4/95

Dynamic Soil Pressure (Mononobe Okabe)

(Sample Cals To check Spread sheet)

$$\beta = i = \delta = 0 \cdot \frac{\pi}{180} = 0 \text{ Rad.}$$

$$\phi = 40 \times \frac{\pi}{180} = .698 \text{ Rad.}$$

$$\gamma = 110 \text{ PCF}$$

$$H = 18 \text{ FT.}$$

$$k_h = k_v = 0.5 g$$

I) ASCE 4-86

$$\psi = \tan^{-1} \left(\frac{k_h}{1 - k_v} \right) = 0.785$$

$$P_{ae} = \frac{H^2}{2} \cdot \gamma \cdot (1 - k_v) \frac{\cos^2(\phi - \psi - \beta)}{\cos \gamma \cdot \cos^2 \beta \cdot \cos(\delta + \beta + \psi)} \times A$$

where:

$$A = \left[1 + \left(\frac{-\sin(\phi + \delta) \cdot \sin(\phi - i - \psi)}{\cos(\beta - i) \cdot \cos(\delta + \beta + \psi)} \right)^{1/2} \right]^2$$

TOTAL Pressure:

$$P_{ae} = 10773 \text{ lb/L.F.} \rightarrow P_{aa} = 10773 / (H/2) = 1197 \text{ PSF}$$

(Assuming Triangular Dist.)

$$P_a = \frac{H^2}{2} \cdot \gamma \cdot \frac{\cos^2(\phi - \beta)}{\cos^2 \beta \cdot \cos(\delta + \beta) \cdot \left[1 + \left(\frac{\sin(\phi + \delta) \cdot \sin(\phi - i)}{\cos(\beta - i) \cdot \cos(\delta + \beta)} \right)^{1/2} \right]^2}$$

$$= 3875$$

$$P_a = 3875 / (H/2) = 431 \text{ PSF}$$

EVALUATION OF NMSF @ LANL
AS-BUILT
LANLDESIGNED BY BM DATE 3/10/92
CHECKED BY JV DATE 5/21/95II - SOIL DYNAMICS, BY SHAMSHER PRAKASH

$$\psi = \tan^{-1} \left(\frac{k_h}{1 + k_v} \right) = 0.322 \text{ Rad. } \checkmark$$

Sub $-k_v$ for k_v in equation for P_{ae} :

$$P_{ae} = \frac{H_z}{2} \cdot \gamma \cdot (1 + k_v) \cdot \frac{1}{\cos \psi}$$
$$= 11431 \text{ lb/L.F.}$$

$$p_{ae} = 11431 / (H/2) = 1270 \text{ PSF } \checkmark$$

$$P_a = 3875 \text{ lb/L.F.} \rightarrow p_a = 431 \text{ PSF } \checkmark$$

$$P_d = P_{ae} - P_a = 7556 \rightarrow p_d = 7556 / 9 = 840 \text{ PSF } \checkmark$$

III EPRI REPORT NP-6041-SL REV 1

$$P_d = 0.15 \cdot \gamma \cdot H^2 \cdot (0.75 k_h)$$

$$= 6683 \text{ lb/L.F.} \rightarrow p_d = \frac{6683}{9} = 743 \text{ PSF } \checkmark$$

STATIC Soil Pressure (Damen & Moore, 1972)

$$P_s = 25 H = 25 \times 18 = 450 \text{ PSF. } \checkmark$$

LAL
 SECTOR, EVALUATION OF NMSF
 FACILITY AT LAL
 AS-Built structure
 CALC # 50001, Rev. 0
 JOB # 41552

west

Mononobe Okabe Analysis of Typical East Wall Section (Line 1 between B and G)

Parameter	(units):		(1)	(2)	(3)
Slope of Back of Wall to Vertical (rad):	Beta=		0	0	
Slope of Ground Behind Wall (rad):	i=		0	0	
Angle of Friction - Soil to Wall (rad):	Delta=		0	0	
Internal Angle of Friction - Soil (deg):	Phi=		40	40	
	Phi=		0.698	0.698	
Unit Weight of Soil (pcf):	Gamma		110	110	110
Wall Height (ft):	H=		18	18	18
Horizontal Ground Acceleration (g):	Kh=		0.5	0.5	0.5
Vertical Ground Acceleration (g):	Kv=		0.5	-0.5	
chi = atan (Kh/(1-Kv)) (rad):	chi=		0.785 ✓	0.322 ✓	
Total Soil Pressure (psf):	pae=		1197 ✓	1270 ✓	
Static Soil Pressure (psf):	pa=		431 ✓	431 ✓	
Dynamic Soil Pressure Increment (psf):	pd=		766	840	743
Static Soil Pressure (psf):	ps=		450 ✓	450 ✓	450
Total Dynamic Force (lb/ft):	Pd=		6894	7556	6683
Total Static Force (lb/ft):	Ps=		6480	6480	6480

- (1) - Mononobe Okabe as represented in ASCE 4-86
 (2) - Mononobe Okabe as represented in "Soil Dynamics, By Prakash", 1981.
 (3) - Dynamic Soil Pressure Increment Given by EPRI Report NP-6041-SL, Rev. 1, App. C

Sheet of 274

West
Mononobe Okabe Analysis of Typical East Wall Section (Line 1 between B and G)

Parameter	(units):		(1)	(2)	(3)
Slope of Back of Wall to Vertical (rad):	Beta=	0	0		
Slope of Ground Behind Wall (rad):	i=	0	0		
Angle of Friction - Soil to Wall (rad):	Delta=	0	0		
Internal Angle of Friction - Soil (deg):	Phi=	40	40		
	Phi=	0.698	0.698		
Unit Weight of Soil (pcf):	Gamma	110	110		110
Wall Height (ft):	H=	35.9	35.9		35.9
Horizontal Ground Acceleration (g):	Kh=	0.3	0.3		0.3
Vertical Ground Acceleration (g):	Kv=	0.2	-0.2		
chi = atan (Kh/(1-Kv)) (rad):	chi=	0.359	0.245		
Total Soil Pressure (psf):	pa _e =	1467	1719		
Static Soil Pressure (psf):	pa=	859	859		
Dynamic Soil Pressure Increment (psf):	pd=	608	861		889
Static Soil Pressure (psf):	ps=	897.5	897.5		897.5
Total Dynamic Force (lb/ft):	Pd=	10914	15447		15949
Total Static Force (lb/ft):	Ps=	25776	25776		25776

(1) - Mononobe Okabe as represented in ASCE 4-86

(2) - Mononobe Okabe as represented in "Soil Dynamics, By Prakash", 1981.

(3) - Dynamic Soil Pressure Increment Given by EPRI Report NP-6041-SL, Rev. 1, App. C

FILE # S-0001, FIG 0
 JOB # 41552
 LANC
 STRUCTURAL EVALUATION OF NMSF FACILITY @ LANC
 As-Built Structure
 SHEET 20 of 274

East

Mononobe Okabe Analysis of Typical ~~West~~ Wall Section (Line 3 between B and G)

Parameter	(units):		(1)	(2)	(3)
Slope of Back of Wall to Vertical (rad):	Beta=	0	0		
Slope of Ground Behind Wall (rad):	i=	0	0		
Angle of Friction - Soil to Wall (rad):	Delta=	0	0		
Internal Angle of Friction - Soil (deg):	Phi=	40	40		
	Phi=	0.698	0.698		
Unit Weight of Soil (pcf):	Gamma	110	110		110
Wall Height (ft):	H=	21	21		21
Horizontal Ground Acceleration (g):	Kh=	0.3	0.3		0.3
Vertical Ground Acceleration (g):	Kv=	0.2	-0.2		
chi = atan (Kh/(1-Kv)) (rad):	chi=	0.359	0.245		
Total Soil Pressure (psf):	pae=	858	1006		
Static Soil Pressure (psf):	pa=	502	502		
Dynamic Soil Pressure Increment (psf):	pd=	356	503		520
Static Soil Pressure (psf):	ps=	525	525		525
Total Dynamic Force (lb/ft):	Pd=	3734	5286		5457
Total Static Force (lb/ft):	Ps=	8820	8820		8820

- (1) - Mononobe Okabe as represented in ASCE 4-86
 (2) - Mononobe Okabe as represented in "Soil Dynamics, By Prakash", 1981.
 (3) - Dynamic Soil Pressure Increment Given by EPRI Report NP-6041-SL, Rev. 1, App. C

Code # S-0001, Rev. 0
 Job # 41542
 LNL
 STRUCTURAL EVALUATION OF NMSP FACILITY AT LNL
 As-Built Structures
 Sheet 21 of 77

ANALYSIS OF WEST WALL SECTION - MONONOBE OKABE DYNAMIC SOIL PRESSURE (WEST31)

C	REV.	DATE	FILE	DESCRIPTION
C	12-	7-94	B.MOSADDAD	WEST1 ORIGINAL
	12-	09-94	BM	WEST2 ADD TRIANGULAR DYN. PRESSURE
	12-	12-94	BM	WEST3 ADD TRIANGULAR STATIC PRESSURE
	12-	14-94	BM	WEST31 ADD SURCHARGE (L=6)

C
C
SYSTEM

L=6

JOINTS

1	X=0	Y=0	S=12
3	X=0	Y=21	
5	X=0	Y=35.88	
50	X=1	Y=0	

RESTRAINTS

1	5	2	R=0,0,1,1,1,0
1			R=1,1,1,1,1,1
3			R=1,0,1,1,1,0
5			R=1,0,1,1,1,0
50			R=1,1,1,1,1,1

FRAME

NM=2 NL=10 NSEC=8

1 SH=R T=18,12 E=3600.

2 SH=R T=16,12 E=3600.

C $0.2 \times 35.88 / 21 = 0.34$, $(.8 \times 35.88 - 21) / 14.88 = 0.52$

1 TRAP=0,0,0,-.34,0.075,0,-1.,0.075,0 :STATIC-TRAP BSMNT

1 TRAP=0,0.075,0,-.52,0.075,0,-1.,0,0 :STATIC-TARP 1ST FLR

L=0,0.036,0 :DYN. SOIL PRESSURE, UNIFORM

L=0,0.0056,0 :INERTIA- BASEMENT

5 WL=0,0.0050,0 :INERTIA- 1ST FLR

6 TRAP=0,0,0,-1,0.042,0 :DYN SOIL PRESSURE TRIANGULAR BSMNT

7 TRAP=0,0.042,0,-1,0.072,0 :DYN SOIL PRESSURE TRIANGULAR 1ST FLR

8 TRAP=0,0.10,0,-1,0.04,0 :STATIC- TRIANGULAR BSMNT

9 TRAP=0,0.04,0,-1.,0,0 :STATIC- TRIANGULAR 1ST FLR

C ----- q=250 PSF SURCHARGE, w=kA x q=0.3*0.250/12=0.0063 K/IN

10 WL=0,0.0063,0

1 1 3 M=1,1 LP=0,50 NSL=1,3,4,6,8,10

2 3 5 M=2,2 LP=0,50 NSL=2,3,5,7,9,10

COMBO

1 C=1,0,0,0,0,0 :STATIC-TRAP

2 C=0,1,0,0,0,0 :DYNAMIC, UNIF

3 C=0,0,1,0,0,0 :INERTIAL

4 C=0,0,0,1,0,0 :DYNAMIC, TRIANGULAR

5 C=0,0,0,0,1,0 :STATIC-TRIANGULAR

6 C=1,1,1,0,0,1 :LC1 S1 +D1 +I +Q

7 C=1,0,1,1,0,1 :LC2 S1 +D2 +I +Q

8 C=0,1,1,0,1,1 :LC3 S2+ D1 +I +Q

9 C=0,0,1,1,1,1 :LC4 S2+ D2 +I +Q

As built

STRUCTURAL ANALYSIS PROGRAMS

VERSION P5.40

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C S I / S A P 9 0 - - F I N I T E E L E M E N T A N A L Y S I S O F S T R U C T U R E S P A G E 1
 PROGRAM: SAP90/FILE: WEST31.F3F
 A N A L Y S I S O F W E S T W A L L S E C T I O N - M O N O N O B E O K A B E D Y N A M I C S O I L P R E S S U R E (

R A M E E L E M E N T F O R C E S

ELT	LOAD	DIST	1-2 PLANE		AXIAL	1-3 PLANE		AXIAL
ID	COMB	ENDI	SHEAR	MOMENT	FORCE	SHEAR	MOMENT	TORQ
1								
1		0.000			0.000			
		0.000	-6.840	370.168				
		36.000	-6.273	130.735				
		72.000	-4.571	-67.858				
		108.000	-1.953	-186.393				
		144.000	0.747	-208.101				
		180.000	3.447	-132.609				
		216.000	6.147	40.083				
		252.000	8.847	309.974				
		252.000			0.000			
2		0.000			0.000			
		0.000	-4.699	204.062				
		36.000	-3.403	58.240				
		72.000	-2.107	-40.925				
		108.000	-0.811	-93.435				
		144.000	0.485	-99.289				
		180.000	1.781	-58.487				
		216.000	3.077	28.972				
		252.000	4.373	163.086				
		252.000			0.000			
3		0.000			0.000			
		0.000	-0.739	32.415				
		36.000	-0.537	9.441				
		72.000	-0.336	-6.275				
		108.000	-0.134	-14.733				
		144.000	0.067	-15.934				
		180.000	0.269	-9.877				
		216.000	0.471	3.437				
		252.000	0.672	24.009				
		252.000			0.000			
4		0.000			0.000			
		0.000	-1.289	64.153				
		36.000	-1.181	19.040				
		72.000	-0.857	-18.298				
		108.000	-0.317	-40.083				
		144.000	0.439	-38.540				
		180.000	1.411	-5.893				
		216.000	2.599	65.634				
		252.000	4.003	183.816				
		252.000			0.000			
5		0.000			0.000			
		0.000	-11.192	473.699				
		36.000	-7.746	133.731				
		72.000	-4.609	-87.745				
		108.000	-1.781	-201.839				

R A M E E L E M E N T F O R C E S

ELT LOAD ID COMB	DIST ENDI	1-2 PLANE		AXIAL FORCE	1-3 PLANE		AXIAL TORQ
		SHEAR	MOMENT		SHEAR	MOMENT	
	144.000	0.739	-219.658				
	180.000	2.951	-152.312				
	216.000	4.854	-10.908				
	252.000	6.448	193.444				
	252.000			0.000			
6	0.000			0.000			
	0.000	-13.100	642.356				
	36.000	-10.808	208.608				
	72.000	-7.382	-122.220				
	108.000	-3.040	-310.912				
	144.000	1.385	-340.700				
	180.000	5.809	-211.208				
	216.000	10.234	77.561				
	252.000	14.658	525.610				
	252.000			0.000			
7	0.000			0.000			
	0.000	-9.690	502.447				
	36.000	-8.587	169.408				
	72.000	-6.133	-99.593				
	108.000	-2.546	-257.560				
	144.000	1.338	-279.951				
	180.000	5.439	-158.615				
	216.000	9.755	114.223				
	252.000	14.287	546.340				
	252.000			0.000			
8	0.000			0.000			
	0.000	-17.452	745.886				
	36.000	-12.282	211.604				
	72.000	-7.420	-142.108				
	108.000	-2.867	-326.359				
	144.000	1.377	-352.257				
	180.000	5.313	-230.911				
	216.000	8.940	26.570				
	252.000	12.259	409.079				
	252.000			0.000			
9	0.000			0.000			
	0.000	-14.042	605.977				
	36.000	-10.060	172.404				
	72.000	-6.171	-119.480				
	108.000	-2.374	-273.006				
	144.000	1.331	-291.508				
	180.000	4.942	-178.318				
	216.000	8.462	63.232				
	252.000	11.888	429.809				
	252.000			0.000			

R A M E E L E M E N T F O R C E S

ELT	LOAD	DIST	1-2 PLANE		AXIAL	1-3 PLANE		AXIAL
ID	COMB	ENDI	SHEAR	MOMENT	FORCE	SHEAR	MOMENT	TORQ
2								
1		0.000			0.000			
		0.000	-7.918	309.974				
		25.509	-6.005	132.406				
		51.017	-4.091	3.638				
		76.526	-2.178	-76.327				
		102.034	-0.302	-107.605				
		127.543	1.121	-95.944				
		153.051	1.976	-55.234				
		178.560	2.260	0.000				
		178.560			0.000			
2		0.000			0.000			
		0.000	-4.127	163.086				
		25.509	-3.209	69.514				
		51.017	-2.291	-0.634				
		76.526	-1.372	-47.356				
		102.034	-0.454	-70.654				
		127.543	0.464	-70.528				
		153.051	1.382	-46.976				
		178.560	2.301	0.000				
		178.560			0.000			
3		0.000			0.000			
		0.000	-0.581	24.009				
		25.509	-0.453	10.819				
		51.017	-0.326	0.882				
		76.526	-0.198	-5.801				
		102.034	-0.071	-9.231				
		127.543	0.057	-9.407				
		153.051	0.184	-6.330				
		178.560	0.312	0.000				
		178.560			0.000			
4		0.000			0.000			
		0.000	-5.672	183.816				
		25.509	-4.546	53.261				
		51.017	-3.311	-47.177				
		76.526	-1.966	-114.708				
		102.034	-0.512	-146.545				
		127.543	1.051	-139.899				
		153.051	2.724	-91.980				
		178.560	4.506	0.000				
		178.560			0.000			
5		0.000			0.000			
		0.000	-3.464	193.444				
		25.509	-2.517	117.472				
		51.017	-1.715	63.810				
		76.526	-1.059	28.739				

R A M E E L E M E N T F O R C E S

ELT LOAD ID COMB	DIST ENDI	1-2 PLANE SHEAR	MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	MOMENT	AXIAL TORQ
	102.034	-0.549	8.540				
	127.543	-0.184	-0.504				
	153.051	0.034	-2.111				
	178.560	0.107	0.000				
	178.560			0.000			
6	0.000			0.000			
	0.000	-13.348	525.610				
	25.509	-10.229	224.903				
	51.017	-7.109	3.776				
	76.526	-3.989	-137.772				
	102.034	-0.906	-199.855				
	127.543	1.724	-188.221				
	153.051	3.784	-116.761				
	178.560	5.276	0.000				
	178.560			0.000			
7	0.000			0.000			
	0.000	-14.893	546.340				
	25.509	-11.565	208.650				
	51.017	-8.129	-42.767				
	76.526	-4.583	-205.124				
	102.034	-0.964	-275.745				
	127.543	2.311	-257.592				
	153.051	5.126	-161.765				
	178.560	7.481	0.000				
	178.560			0.000			
8	0.000			0.000			
	0.000	-8.895	409.079				
	25.509	-6.741	209.970				
	51.017	-4.732	63.947				
	76.526	-2.870	-32.706				
	102.034	-1.153	-83.710				
	127.543	0.418	-92.781				
	153.051	1.843	-63.638				
	178.560	3.122	0.000				
	178.560			0.000			
9	0.000			0.000			
	0.000	-10.439	429.809				
	25.509	-8.078	193.717				
	51.017	-5.752	17.404				
	76.526	-3.463	-100.058				
	102.034	-1.211	-159.601				
	127.543	1.005	-162.152				
	153.051	3.184	-108.642				
	178.560	5.328	0.000				
	178.560			0.000

WEST31 FRAME LOADS LOAD I	MINIMA W 0.7500E-01 P 0.0000E+00 MAXIMA W 0.7500E-01 P 0.0000E+00	SAP90

<div>Y</div> <div>X</div>			
WEST31		LOAD	2
FRAME			
LOADS			
MINIMA		MAXIMA	
W	0.3600E-01	W	0.3600E-01
P	0.0000E+00	P	0.0000E+00
SAP90			

<p>Y X</p>	<p>WEST31 FRAME LOADS LOAD 3</p>	<p>MINIMA W 0.5000E-02 P 0.0000E+00 MAXIMA W 0.5600E-02 P 0.0000E+00</p>	<p>SAP90</p>

WEST31

FRAME

LOADS

LOAD 5

MINIMA

W 0.4000E-01

P 0.0000E+00

MAXIMA

W 0.1000E+00

P 0.0000E+00

SAP90

WEST31	6
FRAME	
LOADS	
LOAD	
MINIMA	
W 0.6300E-02	
P 0.0000E+00	
MAXIMA	
W 0.6300E-02	
P 0.0000E+00	
SAP90

<div>Y ↑ X →</div>		WEST31	
		FRAME	
		OUTPUT M33	
		LOAD 7	
MIN < 1 >		-0.2800E+03	
AT 144.00		MAX < 1 >	
		0.5463E+03	
AT 252.00			
SAP90

ANALYSIS OF EAST WALL SECTION - MONONOBE OKABE DYNAMIC SOIL PRESSURE (EAST11)

C	REV.	DATE	FILE	DESCRIPTION
C	12- 7-94	B.MOSADDAD	WEST1	ORIGINAL
	12-09-94	BM	WEST2	ADD TRIANGULAR DYN. PRESSURE
	12-09-94	BM	EAST1	EAST WALL MODEL
	12-12-94	BM		ADD TRIANGULAR STATIC PRESSURE
C	12-14-94	BM	EAST11	ADD SURCHARGE LOAD (L=6)

SYSTEM
L=6

JOINTS

1 X=0 Y=0 S=12
3 X=0 Y=21
5 X=0 Y=35.88
50 X=1 Y=0

RESTRAINTS

1 5 2 R=0,0,1,1,1,0
1 R=1,1,1,1,1,1
3 R=1,0,1,1,1,0
5 R=1,0,1,1,1,0
50 R=1,1,1,1,1,1

FRAME

NM=2 NL=6 NSEC=8

1 SH=R T=18,12 E=3600.

2 SH=R T=16,12 E=3600.

1 TRAP=0,0,0,-.2,0.044,0,-.8,0.044,0,-1.,0,0 :STATIC-TRAP

1 T=0,0.021,0 :DYN. SOIL PRESSURE, UNIFORM

1 I=0,0.0056,0 :INERTIA- BASEMENT

1 TRAP=0,0,0,-1,0.042,0 :DY. SOIL PRESSURE TRIANGULAR

1 TRAP=0,.058,0,-1.,0,0 :STATIC- TRIANGULAR

C SURCHARGE OF 250 PSF, $Q=0.3*0.250/12=0.0063$

6 WL=0,0.0063,0

1 1 3 M=1,1 LP=0,50 NSL=1,2,3,4,5,6

2 3 5 M=2,2 LP=0,50

COMBO

1 C=1,0,0,0,0,0 :STATIC-TRAP

2 C=0,1,0,0,0,0 :DYNAMIC, UNIF

3 C=0,0,1,0,0,0 :INERTIAL

4 C=0,0,0,1,0,0 :DYNAMIC, TRIANGULAR

5 C=0,0,0,0,1,0 :STATIC-TRIANGULAR

6 C=1,1,1,0,0,1 :LC1 S1 +D1 +I +Q

7 C=1,0,1,1,0,1 :LC2 S1 +D2 +I +Q

8 C=0,1,1,0,1,1 :LC3 S2+ D1 +I +Q

9 C=0,0,1,1,1,1 :LC4 S2+ D2 +I +Q

VERSION P5.40

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R A M E E L E M E N T F O R C E S

ELT LOAD ID COMB	DIST ENDI	1-2 PLANE SHEAR	MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	MOMENT	AXIAL TORQ
1							
1	0.000			0.000			
	0.000	-5.168	277.172				
	36.000	-4.603	97.902				
	72.000	-3.109	-42.102				
	108.000	-1.525	-125.517				
	144.000	0.059	-151.909				
	180.000	1.643	-121.276				
	216.000	3.136	-34.053				
	252.000	3.702	92.434				
	252.000			0.000			
2	0.000			0.000			
	0.000	-3.023	142.550				
	36.000	-2.267	47.329				
	72.000	-1.511	-20.676				
	108.000	-0.755	-61.465				
	144.000	0.001	-75.038				
	180.000	0.757	-61.395				
	216.000	1.513	-20.536				
	252.000	2.269	47.539				
	252.000			0.000			
3	0.000			0.000			
	0.000	-0.806	38.013				
	36.000	-0.605	12.621				
	72.000	-0.403	-5.514				
	108.000	-0.201	-16.391				
	144.000	0.000	-20.010				
	180.000	0.202	-16.372				
	216.000	0.403	-5.476				
	252.000	0.605	12.677				
	252.000			0.000			
4	0.000			0.000			
	0.000	-2.042	126.857				
	36.000	-1.934	54.655				
	72.000	-1.610	-9.771				
	108.000	-1.070	-58.645				
	144.000	-0.314	-84.191				
	180.000	0.658	-78.634				
	216.000	1.846	-34.196				
	252.000	3.250	56.898				
	252.000			0.000			
5	0.000			0.000			
	0.000	-5.530	218.526				
	36.000	-3.591	55.243				
	72.000	-1.951	-43.611				
	108.000	-0.608	-88.774				

R A M E E L E M E N T F O R C E S

ELT LOAD ID COMB	DIST ENDI	1-2 PLANE		AXIAL FORCE	1-3 PLANE		AXIAL TORQ
		SHEAR	MOMENT		SHEAR	MOMENT	
	144.000	0.436	-90.983				
	180.000	1.181	-60.977				
	216.000	1.629	-9.495				
	252.000	1.778	52.725				
	252.000			0.000			
6	0.000			0.000			
	0.000	-9.904	500.501				
	36.000	-8.154	172.052				
	72.000	-5.476	-74.494				
	108.000	-2.708	-221.812				
	144.000	0.060	-269.468				
	180.000	2.829	-217.461				
	216.000	5.507	-66.226				
	252.000	7.257	166.912				
	252.000			0.000			
7	0.000			0.000			
	0.000	-8.923	484.808				
	36.000	-7.821	179.378				
	72.000	-5.575	-63.590				
	108.000	-3.023	-218.993				
	144.000	-0.254	-278.621				
	180.000	2.730	-234.700				
	216.000	5.840	-79.886				
	252.000	8.238	176.271				
	252.000			0.000			
8	0.000			0.000			
	0.000	-10.266	441.855				
	36.000	-7.143	129.392				
	72.000	-4.318	-76.003				
	108.000	-1.791	-185.068				
	144.000	0.437	-208.542				
	180.000	2.367	-157.163				
	216.000	3.999	-41.668				
	252.000	5.333	127.203				
	252.000			0.000			
9	0.000			0.000			
	0.000	-9.285	426.162				
	36.000	-6.809	136.718				
	72.000	-4.416	-65.098				
	108.000	-2.106	-182.249				
	144.000	0.123	-217.696				
	180.000	2.269	-174.401				
	216.000	4.333	-55.328				
	252.000	6.314	136.562				
	252.000			0.000			

R A M E E L E M E N T F O R C E S

ELT LOAD ID COMB	DIST ENDI	1-2 PLANE SHEAR	MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	MOMENT	AXIAL TORQ
2	-----	-----	-----	-----			
1	0.000			0.000			
	0.000	-0.518	92.434				
	25.509	-0.518	79.229				
	51.017	-0.518	66.024				
	76.526	-0.518	52.820				
	102.034	-0.518	39.615				
	127.543	-0.518	26.410				
	153.051	-0.518	13.205				
	178.560	-0.518	0.000				
	178.560			0.000			
2	0.000			0.000			
	0.000	-0.266	47.539				
	25.509	-0.266	40.748				
	51.017	-0.266	33.957				
	76.526	-0.266	27.165				
	102.034	-0.266	20.374				
	127.543	-0.266	13.583				
	153.051	-0.266	6.791				
	178.560	-0.266	0.000				
	178.560			0.000			
3	0.000			0.000			
	0.000	-0.071	12.677				
	25.509	-0.071	10.866				
	51.017	-0.071	9.055				
	76.526	-0.071	7.244				
	102.034	-0.071	5.433				
	127.543	-0.071	3.622				
	153.051	-0.071	1.811				
	178.560	-0.071	0.000				
	178.560			0.000			
4	0.000			0.000			
	0.000	-0.319	56.898				
	25.509	-0.319	48.770				
	51.017	-0.319	40.641				
	76.526	-0.319	32.513				
	102.034	-0.319	24.385				
	127.543	-0.319	16.257				
	153.051	-0.319	8.128				
	178.560	-0.319	0.000				
	178.560			0.000			
5	0.000			0.000			
	0.000	-0.295	52.725				
	25.509	-0.295	45.193				
	51.017	-0.295	37.661				
	76.526	-0.295	30.129				

R A M E E L E M E N T F O R C E S

ELT LOAD ID COMB	DIST ENDI	1-2 PLANE		AXIAL FORCE	1-3 PLANE		AXIAL TORQ
		SHEAR	MOMENT		SHEAR	MOMENT	
	102.034	-0.295	22.596				
	127.543	-0.295	15.064				
	153.051	-0.295	7.532				
	178.560	-0.295	0.000				
	178.560			0.000			
6	0.000			0.000			
	0.000	-0.935	166.912				
	25.509	-0.935	143.068				
	51.017	-0.935	119.223				
	76.526	-0.935	95.378				
	102.034	-0.935	71.534				
	127.543	-0.935	47.689				
	153.051	-0.935	23.845				
	178.560	-0.935	0.000				
	178.560			0.000			
7	0.000			0.000			
	0.000	-0.987	176.271				
	25.509	-0.987	151.089				
	51.017	-0.987	125.908				
	76.526	-0.987	100.726				
	102.034	-0.987	75.545				
	127.543	-0.987	50.363				
	153.051	-0.987	25.182				
	178.560	-0.987	0.000				
	178.560			0.000			
8	0.000			0.000			
	0.000	-0.712	127.203				
	25.509	-0.712	109.031				
	51.017	-0.712	90.859				
	76.526	-0.712	72.687				
	102.034	-0.712	54.516				
	127.543	-0.712	36.344				
	153.051	-0.712	18.172				
	178.560	-0.712	0.000				
	178.560			0.000			
9	0.000			0.000			
	0.000	-0.765	136.562				
	25.509	-0.765	117.053				
	51.017	-0.765	97.544				
	76.526	-0.765	78.035				
	102.034	-0.765	58.527				
	127.543	-0.765	39.018				
	153.051	-0.765	19.509				
	178.560	-0.765	0.000				
	178.560			0.000

EAST11
FRAME
LOADS
LOAD 1

MINIMA
W 0.4400E-01
P 0.0000E+00
MAXIMA
W 0.4400E-01
P 0.0000E+00

SAP90

EAST 11
FRAME
LOADS
LOAD 2

MINIMA
W 0.2100E-01
P 0.0000E+00
MAXIMA
W 0.2100E-01
P 0.0000E+00

SAP90

<div>EAST11</div> <div>FRAME</div> <div>LOADS</div> <div>LOAD 3</div>	<div>MINIMA</div> <div>w 0.5600E-02</div> <div>P 0.0000E+00</div> <div>MAXIMA</div> <div>w 0.5600E-02</div> <div>P 0.0000E+00</div>	<div>SAP90</div>
<div></div>			

<p>Y ↑ X ↑</p>	<p>EAST I I FRAME LOADS LOAD 4</p>	<p>MINIMA W 0.4200E-01 P 0.0000E+00 MAXIMA W 0.4200E-01 P 0.0000E+00</p>	<p>SAP90</p>

<div>Y ↑</div> <div>X →</div>			
EAST11			5
FRAME			
LOADS			
LOAD			
MINIMA			
W 0.5800E-01			
P 0.0000E+00			
MAXIMA			
W 0.5800E-01			
P 0.0000E+00			
		SAP90

EAST11 FRAME LOADS LOAD 6	MINIMA W 0.6300E-02 P 0.0000E+00 MAXIMA W 0.6300E-02 P 0.0000E+00	SAP90

EAST 11
FRAME
OUTPUT M33
LOAD 6

MIN < 1 >
-0.2695E+03
AT 144.00
MAX < 1 >
0.5005E+03
AT 0.00

SAP90

EAST11

FRAME

OUTPUT

LOAD

V22

6

MIN < 1 >

-0.9904E+01

AT 0.00

MAX < 1 >

0.7257E+01

AT 252.00

SAP90

EAST11
FRAME
OUTPUT V22
LOAD 8

MIN < 1>
-0.1027E+02
AT 0.00
MAX < 1>
0.5333E+01
AT 252.00

SAP90

EAST11
FRAME
OUTPUT V22
LOAD 9

MIN < 1>
-0.9285E+01
AT 0.00
MAX < 1>
0.6314E+01
AT 252.00

SAP90

LANL

STRUCTURAL EVALUATION OF NMSF FACILITY AT LANL

As-Built Structure

DESIGNED BY B. Mosaddad DATE 3/10/95

CHECKED BY JV DATE 5/2/95

5.0 THREE DIMENSIONAL DYNAMIC ANALYSIS**C5.1 3-DIMENSIONAL MODEL DEVELOPMENT**

The 3-D model is constructed using shell element to represent the major exterior and interior walls of the NMSF building. Several different versions of the model was utilized in this evaluation are described below.

NMSF0:

This model represent the fixed base configuration of the building without consideration for the surrounding soil, embedment and lateral soil pressure. The mass of building is included as a distributed mass density of the shell elements. This model was used to compute fundamental natural frequencies and the mode shapes of the fixed base structure.

NMSF01:

This version of the model included soil springs representing the foundation impedance functions. This model was used to compute the fundamental natural frequencies and the mode shapes of the building taking into account the SSI effects.

NMSF41:

This is the version of the model that was use to carry out the final set of dynamic analyses used in the structural evaluation of the building.

The following features are added to the NMSF01 model to create NMSF41:

- 1) The floor masses, including the tributary wall masses, are calculated for each floor and placed at a distance equal to 5% of the building dimensions away from the center of rigidity to account for accidental torsion loads.
- 2) The floor mass, located at the floor levels are connected to the corresponding wall nodes using rigid links, simulating a rigid diaphragm at basement, 1st floor and roof elevations.
- 3) The static and dynamic lateral soil pressures ($H_s + H_d$) are applied at the exterior walls in the West and North sides. The passive soil pressures on the east and south walls are neglected, conservatively.
- 4) This model was used to compute the member stresses due to seismic load combinations:

LANL

STRUCTURAL EVALUATION OF NMSF FACILITY AT LANL

As-Built Structure

DESIGNED BY B. Mosaddad DATE 3/10/95

CHECKED BY JL DATE 5/2/95

$D + L + H_s + H_d + E$
and $D + L + H_s + H_d - E$

NMSF42:

This model, essentially the same as NMSF41, was used to carry out analysis for the static load case of:

$$1.4D + 1.7L + 1.7H_s$$

**ICF KAISER
ENGINEERS**

Calc. No. S-0001 Rev. 0

JOB NO. 41552
SHEET 67 OF 74

LANL

STRUCTURAL EVALUATION OF NMSF FACILITY AT LANL

As-Built Structure

DESIGNED BY B. Mosaddad DATE 3/10/95
CHECKED BY J ✓ DATE 5/2/95

5.2 FIXED BASE MODEL

Basement & Tunnel Floor
ELEV. 7281'-0"

Basement - Foundation → 1000 → 1999 To 1st Floor
1st Floor → Roof 2000

EVALUATION OF NMSF @ LANL
AS-BUILT

DESIGNED BY BM DATE 3/10/95

CHECKED BY JV DATE 5/2/95

Basement Mezzanine (AS IS Building)

NMSF UNDEFORMED SHAPE	OPTIONS HIDDEN LINES	SAP90
---	-----------------------------	-------------------------	-------

NMSF
UNDEFORMED
SHAPE

OPTIONS
HIDDEN LINES

SAP90

1st Floor walls

NMSF

UNDEFORMED
SHAPE

OPTIONS

HIDDEN LINES

SAP90

Basement walls

UNDEFORMED
SHAPE

JOINT IDS
ALL JOINTS
RESTRAINTS
ELEMENT IDS
WIRE FRAME

SAP90

Int. 77a

Calc. S-0001 Rev. 0 Job # 41552 ch 78 of 272

NMSF
UNDEFORMED
SHAPE

OPTIONS
JOINT IDS
ALL JOINTS
RESTRAINTS
ELEMENT IDS
WIRE FRAME

SAP90

NMSF

UNDEFORMED
SHAPE

OPTIONS

ALL JOINTS
ELEMENT IDS
WIRE FRAME

SAP90

Cad: S-0001, Rev. 0. Job: 41552 317 314 274

NMSF
UNDEFORMED
SHAPE

OPTIONS
ALL JOINTS
ELEMENT IDS
WIRE FRAME

SAP90

				6077	6078	6079	6080	6081
				6072	6073	6074	6075	6076
6028	6029	6030	6067	6068	6069	6070	6071	
6025	6026	6027	6063	6064	6065	6066		
6022	6023	6024	6059	6060	6061	6062		
6019	6020	6021	6055	6056	6057	6058		
6016	6017	6018	6051	6052	6053	6054		
6013	6014	6015	6047	6048	6049	6050		
6010	6011	6012	6043	6044	6045	6046		
6007	6008	6009	6039	6040	6041	6042		
6004	6005	6006	6035	6036	6037	6038		
6001	6002	6003	6031	6032	6033	6034

NMSF
UNDEFORMED
SHAPE

OPTIONS
JOINT IDS
ALL JOINTS
PROPERTY IDS
WIRE FRAME

SAP90

7001	7011	7021	7031	7041	7051	7061	7071	7081	7091	7101
6001	6011	6021	6031	6041	6051	6061	6071	6081	6091	6101
5001	5011	5021	5031	5041	5051	5061	5071	5081	5091	5101
4001	4011	4021	4031	4041	4051	4061	4071	4081	4091	4101
3001	3011	3021	3031	3041	3051	3061	3071	3081	3091	3101
2001	2011	2021	2031	2041	2051	2061	2071	2081	2091	2101
1001	1011	1021	1031	1041	1051	1061	1071	1081	1091	1101

Calc S-0001, Rev. 0 Job# 41552 3/4 82 4 273

NMSF											
		UNDEFORMED SHAPE											
		OPTIONS											
		JOINT IDS											
		ALL JOINTS											
		PROPERTY IDS											
		WIRE FRAME											
		SAP90											
7002		70127022	7032	7042	7052	7062	7072	7082	7092	7102			
* 6002		* 60126022	* 6032	* 6042	* 6052	* 6062	* 6072	* 6082	* 6092	* 6102			
* 5002		* 50125022	* 5032	* 5042	* 5052	* 5062	* 5072	* 5082	* 5092	* 5102			
* 4002		* 40124022	* 4032	* 4042	* 4052	* 4062	* 4072	* 4082	* 4092	* 4102			
3002		30123022	3032	3042	3052	3062	3072	3082	3092	3102			
2002		20122022	2032	2042	2052	2062	2072	2082	2092	2102			
1002		10121022	1032	1042	1052	1062	1072	1082	1092	1102

NMSF
UNDEFORMED
SHAPE

OPTIONS
JOINT IDS
ALL JOINTS
WIRE FRAME

7004	70147024	7034	7044	7054	7064	7074	7084	7094	7104
* 6004	* 60146024	* 6034	* 6044	* 6054	* 6064	* 6074	* 6084	* 6094	* 6104
* 5004	* 50145024	* 5034	* 5044	* 5054	* 5064	* 5074	* 5084	* 5094	* 5104
* 4004	* 40144024	* 4034	* 4044	* 4054	* 4064	* 4074	* 4084	* 4094	* 4104
3004	30143024	3034	3044	3054	3064	3074	3084	3094	3104
2004	20142024	2034	2044	2054	2064	2074	2084	2094	2104
1004	10141024	1034	1044	1054	1064	1074	1084	1094	1104

SAP90

Calc. S-0001, Ew O Job 41552 8/15/94 274

NMSF
UNDEFORMED
SHAPE

OPTIONS
JOINT IDS
ALL JOINTS
PROPERTY IDS
WIRE FRAME

SAP90

7005	7015025	7035	7045	7055	7065	7075	7085	7095	7105	7115	7125
* 6005	* 6015025	* 6035	* 6045	* 6055	* 6065	* 6075	* 6085	* 6095	* 6105	* 6115	* 6125
* 5005	* 5015025	* 5035	* 5045	* 5055	* 5065	* 5075	* 5085	* 5095	* 5105	* 5115	* 5125
* 4005	* 4015025	* 4035	* 4045	* 4055	* 4065	* 4075	* 4085	* 4095	* 4105	* 4115	* 4125
						3075	3085	3095	3105		
						2075	2085	2095	2105		
						1075	1085	1095	1105		

CASE: S-0001, C.W. 0 JOB 41552 Sht. 50 of 274

<div><div>Z</div><div>↑</div><div>Y</div><div>→</div></div>	NMSF UNDEFORMED SHAPE

NMSF
UNDEFORMED
SHAPE

7008	7018	7028	7038	7048	7058	7068	7078	7088	7098	7108	7118	7128
*6008	*6018	*6028	*6038	*6048	*6058	*6068	*6078	*6088	*6098	*6108	*6118	*6128
*5008	*5018	*5028	*5038	*5048	*5058	*5068	*5078	*5088	*5098	*5108	*5118	*5128
*4008	*4018	*4028	*4038	*4048	*4058	*4068	*4078	*4088	*4098	*4108	*4118	*4128

OPTIONS
JOINT IDS
ALL JOINTS
PROPERTY IDS
WIRE FRAME

SAP90

<div><div>Z</div><div></div><div>X</div></div>									
NMSF									
UNDEFORMED									
SHAPE									
OPTIONS									
JOINT IDS									
ALL JOINTS									
RESTRAINTS									
PROPERTY IDS									
WIRE FRAME									
SAP90									

7001

6001

5001

4001

3001

2001

1001

7002

6002

5002

4002

3002

2002

1002

7003

6003

5003

4003

3003

2003

1003

7004

6004

5004

4004

3004

2004

1004

7005

6005

5005

4005

7006

6006

5006

4006

7007

6007

5007

4007

7008

6008

5008

4008

x 7021	x 7022	x 7023	x 7024	x 7025	x 7026	x 7027	x 7028
x 6021	x 6022	x 6023	x 6024	x 6025	x 6026	x 6027	x 6028
x 5021	x 5022	x 5023	x 5024	x 5025	x 5026	x 5027	x 5028
x 4021	x 4022	x 4023	x 4024	x 4025	x 4026	x 4027	x 4028
x 3021	x 3022	x 3023	x 3024				
x 2021	x 2022	x 2023	x 2024				
x 1021	x 1022	x 1023	x 1024

NMSF
UNDEFORMED
SHAPE

OPTIONS
JOINT IDS
ALL JOINTS
PROPERTY IDS
WIRE FRAME

SAP90

211+308
171

x 7041	x 7042	x 7043
x 6041	x 6042	x 6043
x 5041	x 5042	x 5043
x 4041	x 4042	x 4043
x 3041	x 3042	x 3043
x 2041	x 2042	x 2043
x 1041	x 1042	x 1043

7044	7045	7046	7047	7048
x 6044	x 6045	x 6046	x 6047	x 6048
x 5044	x 5045	x 5046	x 5047	x 5048
x 4044	x 4045	x 4046	x 4047	x 4048
x 3044				
x 2044				
x 1044				

NMSF
UNDEFORMED
SHAPE

OPTIONS
JOINT IDS
ALL JOINTS
PROPERTY IDS
WIRE FRAME

SAP90

11/11/90

7061	7062	7063	7064	7065	7066	7067	7068
x 6061	x 6062	x 6063	x 6064	x 6065	x 6066	x 6067	x 6068
x 5061	x 5062	x 5063	x 5064	x 5065	x 5066	x 5067	x 5068
x 4061	x 4062	x 4063	x 4064	x 4065	x 4066	x 4067	x 4068
x 3061	x 3062	x 3063	x 3064				
x 2061	x 2062	x 2063	x 2064				
x 1061	x 1062	x 1063	x 1064				

NMSF
UNDEFORMED
SHAPE

OPTIONS
JOINT IDS
ALL JOINTS
PROPERTY IDS
WIRE FRAME

SAP90

24.94 5.24

24-154-24

NMSF
UNDEFORMED
SHAPE

OPTIONS
JOINT IDS
ALL JOINTS
PROPERTY IDS
WIRE FRAME

SAP90

7071	7072	7073	7074	7075	7076	7077	7078
x	x	x	x	x	x	x	x
6071	6072	6073	6074	6075	6076	6077	6078
x	x	x	x	x	x	x	x
5071	5072	5073	5074	5075	5076	5077	5078
x	x	x	x	x	x	x	x
4071	4072	4073	4074	4075	4076	4077	4078
x	x	x	x	x	x	x	x
3071	3072	3073	3074	3075			
x	x	x	x	x			
2071	2072	2073	2074	2075			
x	x	x	x	x			
1071	1072	1073	1074	1075			
x	x	x	x	x			

815 97 27+

NMSF
UNDEFORMED
SHAPE

OPTIONS
JOINT IDS
ALL JOINTS
PROPERTY IDS
WIRE FRAME

SAP90

7101	7102	7103	7104	7105	7106	7107	7108	7109	7110
6101	6102	6103	6104	6105	6106	6107	6108	6109	6110
5101	5102	5103	5104	5105	5106	5107	5108	5109	5110
4101	4102	4103	4104	4105	4106	4107	4108	4109	4110
3101	3102	3103	3104	3105					
2101	2102	2103	2104	2105					
1101	1102	1103	1104	1105

7125		7126		7127		7128		7129		7130
6125		6126		6127		6128		6129		6130
5125		5126		5127		5128		5129		5130
4125		4126		4127		4128		4129		4130

NMSF
UNDEFORMED
SHAPE

OPTIONS
JOINT IDS
ALL JOINTS
RESTRAINTS
PROPERTY IDS
WIRE FRAME

SAP90

92
1
9
8
1
4

LANL

STRUCT EVAL OF UMSE FACILITY

AS-BUILT STRUCTURE

DESIGNED BY BMDATE 2/1/95CHECKED BY JVDATE 5/2/98Effective shear wall thickness.

openings in the walls are accounted for in calculation of rigidity of the walls by assuming an effective thickness based on equal volume of concrete.

The same effective wall thicknesses are used later in calculation of wall capacities. This method is justified based on the fact that no credit is taken for the reinforcing steel in the walls for their in plane shear capacities and still a comfortable margin of safety is obtained by the calculated Demand/Capacity Ratios.

clarification needed for these walls.

7 8

Ref. ORG.
S5
S2

Basement

NMSF
UNDEFORMED
SHAPE

OPTIONS
ALL JOINTS
ELEMENT IDS
WIRE FRAME

SAP90

Sheet 100 of 271

NMSF
UNDEFORMED
SHAPE

OPTIONS
JOINT IDS
ALL JOINTS
RESTRAINTS
ELEMENT IDS
WIRE FRAME

SAP90

Shit. 101.5. 274

NMSF
UNDEFORMED
SHAPE

OPTIONS
JOINT IDS
ALL JOINTS
PROPERTY IDS
WIRE FRAME

SAP90

7001	7011	7021	7031	7041	7051	7061	7071	7081	7091	7101
6001	6011	6021	6031	6041	6051	6061	6071	6081	6091	6101
5001	5011	5021	5031	5041	5051	5061	5071	5081	5091	5101
4001	4011	4021	4031	4041	4051	4061	4071	4081	4091	4101
3001	3011	3021	3031	3041	3051	3061	3071	3081	3091	3101
2001	2011	2021	2031	2041	2051	2061	2071	2081	2091	2101
1001	1011	1021	1031	1041	1051	1061	1071	1081	1091	1101

$T = 1.5'$ Basement

$T = 1.3$ 1st floor
WALL ON LINE 1

No openings

Sheet 102 of 224

NMSF

UNDEFORMED
SHAPE

OPTIONS

JOINT IDS
ALL JOINTS
PROPERTY IDS
WIRE FRAME

SAP90

7002	70127022	7032	7042	7052	7062	7072	7082	7092	7102
"	"	"	"	"	"	"	"	"	"
6002	60126022	6032	6042	6052	6062	6072	6082	6092	6102
"	"	"	"	"	"	"	"	"	"
5002	50125022	5032	5042	5052	5062	5072	5082	5092	5102
"	"	"	"	"	"	"	"	"	"
4002	40124022	4032	4042	4052	4062	4072	4082	4092	4102
"	"	"	"	"	"	"	"	"	"
3002	30123022	3032	3042	3052	3062	3072	3082	3092	3102
"	"	"	"	"	"	"	"	"	"
2002	20122022	2032	2042	2052	2062	2072	2082	2092	2102
"	"	"	"	"	"	"	"	"	"
1002	10121022	1032	1042	1052	1062	1072	1082	1092	1102
"	"	"	"	"	"	"	"	"	"

No openings

$T = 1'$

WALL ON LINE 1-5

$$T_e = \frac{(21 \times 22.92) - (8 \times 6 + 4 \times 2 + 3 \times 3)}{(21 \times 22.92)} \times 1.33 = 1.15'$$

7003	70137023	7033	7043	7053	7063	7073	7083	7093	7103
6003	60136023	6033	6043	6053	6063	6073	6083	6093	6103
5003	50135023	5033	5043	5053	5063	5073	5083	5093	5103
4003	40134023	4033	4043	4053	4063	4073	4083	4093	4103
3003	30133023	3033	3043	3053	3063	3073	3083	3093	3103
2003	20132023	2033	2043	2053	2063	2073	2083	2093	2103
1003	10131023	1033	1043	1053	1063	1073	1083	1093	1103

$T = 1.4$
 $T = 1'$
 Opening:
 8' x 6'
 4' x 2'
 3' x 3'
 WALL ON LINE 2

NMSF

UNDEFORMED SHAPE

OPTIONS

JOINT IDS

ALL JOINTS

PROPERTY IDS

WIRE FRAME

SAP90

1ST Floor : $T_e = \frac{(135.74 \times 15.5) - (6 \times 2.5 + 2 \times 2.5 + 2 \times 1.5 + 7 \times 4 + 8 \times 9)}{(135.74 \times 15.5)} \times 1.33 = 1.25'$

Basement : $T_e = \frac{(135.74 \times 21) - (7 \times 4 + 8 \times 9)}{135.74 \times 21} \times 1.50 = 1.45'$

NMSF
UNDEFORMED
SHAPE

OPTIONS
JOINT IDS
ALL JOINTS
WIRE FRAME

SAP90

15.5' + 21'

NMSF
UNDEFORMED
SHAPE

OPTIONS
JOINT IDS
ALL JOINTS
PROPERTY IDS
WIRE FRAME

SAP90

7005	7015025	7035	7045	7055	7065	7075	7085	7095	7105	7115	7125
*6005	*6015025	*6035	*6045	*6055	*6065	6075	6085	6095	*6105	*6115	*6125
*5005	*5015025	*5035	*5045	*5055	*5065	5075	5085	5095	*5105	*5115	*5125
*4005	*4015025	*4035	*4045	*4055	*4065	4075	4085	4095	*4105	*4115	*4125
						3075	3085	3095	3105		
						2075	2085	2095	2105		
						1075	1085	1095	1105		

$T = 1'$

NO opening

WALL ON LINE 5-

Shit 1000

$$T_e = \frac{(30 \times 15.5) - (8.7 \times 8.7 + 2 \times 1.5 \times 1.5)}{30 \times 15.5} \times 1.0 = 0.83'$$

NMSF
UNDEFORMED
SHAPE

Openings: $8\frac{2}{3} \times 8\frac{2}{3}$
 $2(1.5 \times 1.5)$

WALL ON LINE 6, 6+

OPTIONS
JOINT IDS
ALL JOINTS
PROPERTY IDS
WIRE FRAME

SAP90

2/11/107

$$T_0 = \frac{(138.33 \times 15.5) - (2 \times 1.75 \times 6 + 7.2 \times 6 + 7.2 \times 3 - 7.2 \times 7.2 - 4 \times 5.3 \times 6 - 8.7 \times 3)}{138.33 \times 15.5} \times 1.0$$

$$= 0.86'$$

NMSF
UNDEFORMED
SHAPE

OPTIONS
JOINT IDS
ALL JOINTS
PROPERTY IDS
WIRE FRAME

SAP90

Sheet 1 of 1

$T=1'$

NO OPENINGS

WALL ON LINE 7+

NMSF
UNDEFORMED
SHAPE

OPTIONS
JOINT IDS
ALL JOINTS
PROPERTY IDS
WIRE FRAME

SAP90

slt 109

Sheet 110 of 110

NMSF
UNDEFORMED
SHAPE

OPTIONS
JOINT IDS
ALL JOINTS
RESTRAINTS
PROPERTY IDS
WIRE FRAME

SAP90

$$\text{1ST Floor: } T_e = \frac{(15.5 \times 72.5) - (10 \times 12 + 7.5 \times 4 + 4 \times 6)}{(15.5 \times 72.5)} \times 1.33$$

$$= 1.12$$

$$\text{Basement: } T_e = \frac{(21 \times 72.5) - (11 \times 11)}{(71 \times 72.5)} \times 1.50$$

$$= 1.38$$

$T = 1'$

$T = 1.5'$ basement
 $T = 1.3'$ 1ST Floor

WALL ON LINE B

opening

1	10' x 12'
2	7' x 4'
3	11' x 11'
4	4' x 6'

NMSF
 UNDEFORMED
 SHAPE

OPTIONS
 JOINT IDS
 ALL JOINTS
 PROPERTY IDS
 WIRE FRAME

SAP90

6/11/98

NMSF

UNDEFORMED
SHAPE

7098	7099
6098	6099
5098	5099
4098	4099

$T=1'$

NO opening

OPTIONS

JOINT IDS
ALL JOINTS
PROPERTY IDS
WIRE FRAME

Sheet 112

SAP90

7091	7092	7093	7094	7095	7096	7097
6091	6092	6093	6094	6095	6096	6097
5091	5092	5093	5094	5095	5096	5097
4091	4092	4093	4094	4095	4096	4097
3091	3092	3093	3094	3095		
2091	2092	2093	2094	2095		
1091	1092	1093	1094	1095		

WALL ON LINE B+

7071	7072	7073	7074	7075	7076	7077	7078
6071	6072	6073	6074	6075	6076	6077	6078
5071	5072	5073	5074	5075	5076	5077	5078
4071	4072	4073	4074	4075	4076	4077	4078
3071	3072	3073	3074	3075			
2071	2072	2073	2074	2075			
1071	1072	1073	1074	1075

WALL ON LINE C+

NMSF
UNDEFORMED
SHAPE

OPTIONS
JOINT IDS
ALL JOINTS
PROPERTY IDS
WIRE FRAME

SAP90

Slt. 11365

$$T_e = \frac{(53.5 \times 15.5) - (2 \times 8 \times 8 + 3 \times 2 \times 2)}{53.5 \times 15.5} \times 0.67 = 0.55'$$

$T = 8''$

WALL ON LINE D-

7065	7066	7067	7068
6065	6066	6067	6068
5065	5066	5067	5068
4065	4066	4067	4068

Openings

1, 2

8' x 8'

3

~ 3' x 2' x 2'

NMSF

UNDEFORMED
SHAPE

OPTIONS

JOINT IDS
ALL JOINTS
PROPERTY IDS
WIRE FRAME

SAP90

Sheet 113 of 114

$$T_e = \frac{(78 \times 15.5) - (7.2 \times 3.5 + 10 \times 10 + 7.2 \times 7.2 + 2 \times 2 \times 11.5 + 6)}{78 \times 15.5} \times 1 = 0.84'$$

Opening	1	2	3	Misc
7.2 x 3.5				2 x (1.5 x 2)
10' x 10'				6 x (1 x 1)
7.2 x 7.2				

WALL ON LINE E+

NMSF
UNDEFORMED
SHAPE

OPTIONS
JOINT IDS
ALL JOINTS
PROPERTY IDS
WIRE FRAME

SAP90

$$T_e = \frac{22.5 \times 15.5 - (3 \times 2 + 2.3 \times 2.3)}{22.5 \times 15.5} \times .67 = .065$$

7021	7022	7023	7024	7025	7026	7027	7028
6021	6022	6023	6024	6025	6026	6027	6028
5021	5022	5023	5024	5025	5026	5027	5028
4021	4022	4023	4024	4025	4026	4027	4028
3021	3022	3023	3024				
2021	2022	2023	2024				
1021	1022	1023	1024

Openings

- 1 3 x 2
- 2 2.3 x 2.3

WALL ON LINE F

NMSF
UNDEFORMED
SHAPE

OPTIONS
JOINT IDS
ALL JOINTS
PROPERTY IDS
WIRE FRAME

SAP90

Sheet 116 of 116

$$T_e = \frac{(23.92 \times 36.5) - (8 \times 6 + 3 \times 2 \frac{3}{4} \times 2 \frac{3}{4} + 2 \times 2 \times 2)}{(23.92 \times 36.5)} \times 1.33 = 1.21$$

$T = 1.33$

openings

8 x 6
3 (2 1/2 x 2 3/4)
2 (2 x 2)

WALL ON LINE F+

NMSF
UNDEFORMED
SHAPE

OPTIONS
JOINT IDS
ALL JOINTS
PROPERTY IDS
WIRE FRAME

SAP90

1st floor $T=1.33'$
Basement $T=1.5'$

7001	7002	7003	7004	7005	7006	7007	7008
6001	6002	6003	6004	6005	6006	6007	6008
5001	5002	5003	5004	5005	5006	5007	5008
4001	4002	4003	4004	4005	4006	4007	4008
3001	3002	3003	3004				
2001	2002	2003	2004				
1001	1002	1003	1004				

No openings

WALL ON LINE G

NMSF
UNDEFORMED
SHAPE

OPTIONS
JOINT IDS
ALL JOINTS
RESTRAINTS
PROPERTY IDS
WIRE FRAME

SAP90

ST. 118 +
* 311.15

LOAD COMBINATIONS

1) Seismic Load Combinations (DOE-STD-1020-94)

$$D = D_s + D_{SI}$$

$$D_s = D_L + L + H_1 + H_2 + T_0$$

Dead Load
Live Load
Static Soil Pressure
Dynamic Soil Pressure
Operating Level
Thermal loads

$D_s =$ DOE Earthquake Response Spectral Analysis

Structure member ductility Ratio (Range 1.0 $\rightarrow$ 1.75 for concrete members).

SF = 1.0
NMSF is Category 3 Facility

2) Non-Seismic Load Combinations (UAC-91, ch 26)

$$D_1 = 1.4 D_L + 1.7 L + 1.7 H_1 + 1.7 T_0$$

$$D_2 = 0.75 (1.4 D_L + 1.7 L + 1.7 H_1 + 1.7 T_0) + 1.05 D_L + 1.28 (L + H_1 + T_0)$$

Accident Level
Thermal loads

ICF KAISER ENGINEERS
Calc. S-0001, Rev 0
EVALUATION OF NMSF COLANL
#5-BUILT STRUCTURE

DESIGNED BY RM
CHECKED BY JL

JOB NO. 415-2
SHEET 14 OF 27

DATE 3/10/95
DATE 5/2/95

SAP90 RUNS

1) Dynamic Run (Seismic Load Combinations)

DL+LL	$\left\{ \begin{array}{l} L=1 \\ L=2 \\ D \end{array} \right.$	NMSF05 ← OPTION 1
H ₁ +H ₂		NMSF41 → AS-15
DSE		

2) Static Run (Non-Seismic Combinations)

DL	L=1
LL	L=2
H ₁	L=3

3) Thermal Analysis

$\left\{ \begin{array}{l} \text{Flexural} \\ \text{Flexural + Axial} \end{array} \right.$	HEAT11	To (Operating)
	HEAT12	
	HEAT21	T _A (Accidental)
	HEAT22	

Job No. 41552	SHEET 130 OF 174
DESIGNED BY B.M.	CHECKED BY J.L.
DATE 3/10/95	DATE 5/7/95

ICF KAISER
ENGINEERS
Calc. S-0001, Rev. 0
EVALUATION OF NMSF @ WALL
AS-BUILT STRUCTURE

Dead load, live load, Masses

USE:

Concrete Wt. Density
Steel
Soil

150 PCF
490
100

ALSO USE:

- 1) Live load 250 PSF
- 2) FUTURE DEAD LOAD 10 PSF
- 3) SNOW LOAD 30 PSF
- 4) Include 25% LL in FLOOR MASS FOR DYNAMIC ANALYSIS

BASEMENT FLOOR (1.5' thick slab)

Equivalent Mass Dens.

$$M = (0.15 + \frac{0.01 + 0.25 \times 0.25}{1.5}) / 32.2 = 0.00616$$

Equivalent DL+LL

$$W_1 = 0.15 + \frac{0.01 + 0.25}{1.5} = 0.323 \text{ KCF}$$

Equivalent 1.4DL+1.7LL

$$W_2 = 1.4 \left(0.15 + \frac{0.01}{1.5} \right) + 1.7 \frac{0.25}{1.5} = 0.503 \text{ KCF}$$

ICF KAISER ENGINEERS
Calc. S-0001, Rev. 0
EVALUATION OF NMSF @ LANT
AS-BUILT STRUCTURE

JOB NO. 41552
SHEET 121 OF 274
DESIGNED BY BM
DATE 3/10/91
CHECKED BY SV
DATE 5/2/95

EVALUATION OF NMSE @ LANL
AS-BUILTDESIGNED BY KMDATE 3/10/95CHECKED BY JVDATE 5/2/951ST FLOOR SLAB / MEZZ SLAB (1' thick SLAB)

Equiv. Mass

$$M_L = (0.15 + \frac{0.01 + 0.25 \times 25}{1}) / 32.2 = 0.00691$$

Equiv. DL+LL

$$W_1 = (0.15 + 0.01 + 0.25) = 0.41 \text{ KCF}$$

Equiv. 1.4DL+1.7LL

$$W_2 = 1.4(0.15 + 0.01) + 1.7 \times 0.25 = 0.649 \text{ KCF}$$

MAA ROOF (1' slab)

Equiv quantities:

snow

2' soil

$$M_L = (0.15 + 0.7 \times 0.03 + 0.2 + 0.01) / 32.2 = 0.01155$$

$$W_1 = (0.15 + 0.03 + 0.2 + 0.01) = 0.39 \text{ KCF}$$

$$W_2 = 1.4(0.15 + 0.01 + 0.2) + 1.7 \times 0.03 = 0.555 \text{ KCF}$$

DOUBLE TEE / CIP ROOF SECTIONS (Equiv TH = .86')

$$M_L = (0.15 + (0.7 \times 0.03 + 0.01) / .86) / 32.2 = 0.0058$$

$$W_1 = 0.15 + (0.03 + 0.01) / .86 = .197$$

$$W_2 = 1.4(0.15 + \frac{0.01}{.86}) + 1.7 \times 0.03 / .86 = .286 \text{ KCF}$$

EVALUATION OF NMSE PLAN
AS-BUILT

DESIGNED BY BSM

DATE 3/10/95

CHECKED BY JL

DATE 5/2/91

PRESTRESSED DOUBLE-TEE ROOF PANELS

Equivalent Uniform Thickness, T_a

$$T_a = \left[8 \times \frac{2.5 + 3}{12} + 2 \times 2.08 \times \frac{7}{12} + 2 \times \frac{7 \times 7}{12 \times 12} \right] / 8 \approx 0.86'$$

CAST-IN-PLACE BEAM AND SLAB ROOF

This segment of the roof spans between lines 3 → 7 and E → G.

We Equiv. Thickness, T_b

$$T_b = \left[60 \times 69 \times 8 + (3 \times 69 + 2 \times 60 + 8 \times 30 + 24)(24 - 8) \right] /$$

$$(60 \times 69) \approx 10.3' \approx 0.86'$$

REF: DOE' DRG NO. LA-ZJ-B.S.3.2

NMSF Model (AS-BUILT)
FLOOR MASS DISTRIBUTION

• Lump mass of Mezz level to 1st floor

ICF KAISER ENGINEERS Calc. S-0001, Rev. 0	
Evaluation of NMSF (AS-BUILT)	
DESIGNED BY <u>BM</u> DATE <u>1/5/95</u>	CHECKED BY <u>IV</u> DATE <u>5/2/95</u>
JOB NO. <u>41572</u> SHEET 124 OF 271	

Evaluation of NMSF DIAM
AS BUILT

DESIGNED BY BM DATE 1/31/95
CHECKED BY JV DATE 5/2/95

NMSF BLDG. (AS-BUILT)

Summary of Floor Mass Calculations:

FLOOR	Mass	Mass	Moment of Inertia	
	$M_x = M_y = M_z$	M_{xx}	M_{yy}	M_{zz}
Basement	129	275712	52970	328683
1st Floor	208	562208	353611	915819
Roof	206	522450	358517	880968
TOTAL	543 K-FT ² -S ²			

FLOOR C.G. Coordinates

	$\bar{X}$	$\bar{Y}$	$\bar{Z}$
Basement	29.98'	77.61'	0
1st Floor	54.15	83.96	21'
Roof	58.73	81.07	36.5'

~~EVALUATION OF NMSF @ LANL~~DESIGNED BY BMDATE 3/10/96

AS-BUILT

CHECKED BY SLDATE 6/2/96

Summary of Dead Loads and Live Loads

<u>FLOOR</u>	<u>DL + L.L.</u>	<u>1.4DL + 1.7LL</u>
Basement	5,807 ^k	8,800 ^k
1st Floor	11,553 ^k	17,935 ^k
Roof	6,849 ^k	9,786 ^k
<u>TOTAL</u>	<u>24,209</u>	<u>36,521^k</u>

ICF KAISER
ENGINEERS

Calc. S-0001, Rev. 0
LANL

SHEET: 127 OF 274

JOB NO.: 41552

DESIGNED BY: BM DATE: 1/30/95

CHECKED BY: JV DATE: 5/4/95

SUBJ: --- Basement Floor Mass

AS-BUILT NMSF

ITEM	XD	YD	H	Xc	Yc	m	M	Xc*M	Yc*M	M*X^2	M*Y^2	Ix0	Iy0
1	53.50	148.70	1.50	26.8	74.4	0.00616	73.5	1966.164	5464.8	767.3315	780.13	135437	17532
2	19.00	44.40	1.50	63.0	126.5	0.00616	7.79	491.0302	985.96	8497.559	18631	1280	234
3	1.50	148.70	10.63	0.0	74.4	0.00466	11	0	820.82	9923.393	117.18	20343	2
4	1.00	128.70	10.63	14.8	64.4	0.00466	6.37	94.27675	409.91	1468.069	1119.7	8793	1
5	1.00	128.70	10.63	29.6	64.4	0.00466	6.37	188.5535	409.91	0.924923	1119.7	8793	1
6	1.45	104.30	10.63	53.5	52.2	0.00466	7.49	400.4704	390.37	4140.497	4851.3	6786	1
7	1.45	44.40	10.63	53.5	126.5	0.00466	3.19	170.4783	403.09	1762.59	7617.2	523	1
8	1.00	44.40	10.63	72.5	126.5	0.00466	2.2	159.3255	278	3972.943	5253.2	361	0
9	72.50	1.38	10.63	36.3	148.7	0.00466	4.95	179.5103	736.36	194.6127	25028	1	2169
10	19.00	1.00	10.63	63.0	104.3	0.00466	0.94	59.24592	98.085	1025.285	670.01	0	28
11	23.90	1.21	10.63	41.6	22.9	0.00466	1.43	59.47283	32.778	191.5735	4284	0	68
12	53.50	1.50	10.63	26.8	0.0	0.00466	3.97	106.251	0	41.46642	23923	1	947
13							0	0	0	0	0	0	0
14							0	0	0	0	0	0	0
15							0	0	0	0	0	0	0
16							0	0	0	0	0	0	0
17							0	0	0	0	0	0	0
18							0	0	0	0	0	0	0
19							0	0	0	0	0	0	0
20							0	0	0	0	0	0	0
21							0	0	0	0	0	0	0
22							0	0	0	0	0	0	0
23							0	0	0	0	0	0	0
24							0	0	0	0	0	0	0
25							0	0	0	0	0	0	0
26							0	0	0	0	0	0	0
27							0	0	0	0	0	0	0
27							0	0	0	0	0	0	0
28							0	0	0	0	0	0	0
29							0	0	0	0	0	0	0
30							0	0	0	0	0	0	0

Total Floor Mass= 129 3874.778 10030 31986.25 93395 182317 20984

C. G. COORDINATES: XCG= 29.98 ft YCG= 77.61 ft Wt.= 4162

MASS MOMENTS OF INERTIA: IXX= 275712 IYY= 52970 IZZ= 328683

Units: Kips, Feet, Second

ICF KAISER
ENGINEERS

Calc. S-0001, Rev. 0
LANI

SHEET: 125 OF 274

JOB NO.: 41952

DATE: 3-1-95

DESIGNED BY: BM

CHECKED BY: JL

DATE: 5/4/00

SUBJ: -- Basement Floor (DL+LL) --

AS-BUILT

ITEM	XD	YD	H	Xc	Yc	m	M	Xc*M	Yc*M	M*X^2	M*Y^2	Ix0	Iy0
1	53.50	148.70	1.50	26.8	74.4	0.01003	120	3202.038	8899.9	1249.654	1270.5	220568	28552
2	19.00	44.40	1.50	63.0	126.5	0.01003	12.7	799.6778	1605.7	13838.88	30343	2085	382
3	1.50	148.70	10.63	0.0	74.4	0.00466	11	0	820.82	9923.393	117.18	20343	2
4	1.00	128.70	10.63	14.8	64.4	0.00466	6.37	94.27675	409.91	1468.069	1119.7	8793	1
5	1.00	128.70	10.63	29.6	64.4	0.00466	6.37	188.5535	409.91	0.924923	1119.7	8793	1
6	1.45	104.30	10.63	53.5	52.2	0.00466	7.49	400.4704	390.37	4140.497	4851.3	6786	1
7	1.45	44.40	10.63	53.5	126.5	0.00466	3.19	170.4783	403.09	1762.59	7617.2	523	1
8	1.00	44.40	10.63	72.5	126.5	0.00466	2.2	159.3255	278	3972.943	5253.2	361	0
9	72.50	1.38	10.63	36.3	148.7	0.00466	4.95	179.5103	736.36	194.6127	25028	1	2169
10	19.00	1.00	10.63	63.0	104.3	0.00466	0.94	59.24592	98.085	1025.285	670.01	0	28
11	23.90	1.21	10.63	41.6	22.9	0.00466	1.43	59.47283	32.778	191.5735	4284	0	68
12	53.50	1.50	10.63	26.8	0.0	0.00466	3.97	106.251	0	41.46642	23923	1	947
13							0	0	0	0	0	0	0
14							0	0	0	0	0	0	0
15							0	0	0	0	0	0	0
16							0	0	0	0	0	0	0
17							0	0	0	0	0	0	0
18							0	0	0	0	0	0	0
19							0	0	0	0	0	0	0
20							0	0	0	0	0	0	0
21							0	0	0	0	0	0	0
22							0	0	0	0	0	0	0
23							0	0	0	0	0	0	0
24							0	0	0	0	0	0	0
25							0	0	0	0	0	0	0
26							0	0	0	0	0	0	0
27							0	0	0	0	0	0	0
27							0	0	0	0	0	0	0
28							0	0	0	0	0	0	0
29							0	0	0	0	0	0	0
30							0	0	0	0	0	0	0

Total Floor Mass= 180 5419.3 14085 37809.89 105596 268254 32151

C. G. COORDINATES: XCG= 30.05 ft YCG= 78.10 ft Wt.= 5807

MASS MOMENTS OF INERTIA: IXX= 373850 IYY= 69961 IZZ= 443812

Units: Kips, Feet, Second

ICF KAISER
ENGINEERS

Calc. S-0001, Rev. 0
LANL

SHEET: 12-1 OF 27-1
JOB NO.: 41552

SUBJ: --Basement Floor (1.4DL + 1.7LL)--

DESIGNED BY: BSM

DATE: 3-1-95

CHECKED BY: J

DATE: 5/9/95

AS-Built NMSF

ITEM	XD	YD	H	Xc	Yc	m	M	Xc*M	Yc*M	M*X^2	M*Y^2	Ix0	Iy0
1	53.50	148.70	1.50	26.8	74.4	0.01562	186	4986.455	13860	1946.056	1978.5	343486	44463
2	19.00	44.40	1.50	63.0	126.5	0.01562	19.8	1245.319	2500.5	21550.95	47252	3247	595
3	1.50	148.70	10.63	0.0	74.4	0.00652	15.5	0	1149.1	13892.75	164.05	28480	3
4	1.00	128.70	10.63	14.8	64.4	0.00652	8.92	131.9874	573.88	2055.297	1567.5	12310	1
5	1.00	128.70	10.63	29.6	64.4	0.00652	8.92	263.9749	573.88	1.294892	1567.5	12310	1
6	1.45	104.30	10.63	53.5	52.2	0.00652	10.5	560.6586	546.51	5796.696	6791.9	9500	2
7	1.45	44.40	10.63	53.5	126.5	0.00652	4.46	238.6696	564.33	2467.625	10664	733	1
8	1.00	44.40	10.63	72.5	126.5	0.00652	3.08	223.0557	389.19	5562.121	7354.5	505	0
9	72.50	1.38	10.63	36.3	148.7	0.00652	6.93	251.3145	1030.9	272.4577	35039	1	3037
10	19.00	1.00	10.63	63.0	104.3	0.00652	1.32	82.94429	137.32	1435.399	938.02	0	40
11	23.90	1.21	10.63	41.6	22.9	0.00652	2	83.26197	45.889	268.203	5997.6	0	95
12	53.50	1.50	10.63	26.8	0.0	0.00652	5.56	148.7514	0	58.05299	33493	1	1326
13							0	0	0	0	0	0	0
14							0	0	0	0	0	0	0
15							0	0	0	0	0	0	0
16							0	0	0	0	0	0	0
17							0	0	0	0	0	0	0
18							0	0	0	0	0	0	0
19							0	0	0	0	0	0	0
20							0	0	0	0	0	0	0
21							0	0	0	0	0	0	0
22							0	0	0	0	0	0	0
23							0	0	0	0	0	0	0
24							0	0	0	0	0	0	0
25							0	0	0	0	0	0	0
26							0	0	0	0	0	0	0
27							0	0	0	0	0	0	0
27							0	0	0	0	0	0	0
28							0	0	0	0	0	0	0
29							0	0	0	0	0	0	0
30							0	0	0	0	0	0	0

Total Floor Mass= 273 8216.392 21371 55306.91 152807 410573 49563

C. G. COORDINATES: XCG= 30.06 ft YCG= 78.20 ft Wt.= 8800

MASS MOMENTS OF INERTIA: IXX= 563380 IYY= 104869 IZZ= 668250

Units: Kips, Feet, Second

Calc S-0001, Rev. 0

ICF KAISER
ENGINEERS

SHEET: 130 OF 274

JOB NO.: 41552

DESIGNED BY: B/M DATE: 3-1-95

CHECKED BY: J.L. DATE: 5/4/95

SUBJECT: --- First Floor Mass

AP = BLUET NMST

ITEM	XD	YD	H	Xc	Yc	m	M	Xc*M	Yc*M	M*X ²	M*Y ²	Ix0	Iy0
1							0	0	0	0	0	0	0
2.1	53.50	20.00	1.00	26.8	138.7	0.00691	7.39	197.7797	1025	5550.398	22157	246	1764
3	1.50	148.70	10.63	0.0	74.4	0.00466	11	0	820.8	32370.23	1018.9	20343	2
4	1.00	128.70	10.63	14.8	64.4	0.00466	6.37	94.27675	409.9	9862.977	2448.8	8793	1
5	1.00	128.70	10.63	29.6	64.4	0.00466	6.37	188.5535	409.9	3838.901	2448.8	8793	1
6	1.45	104.30	10.63	53.5	52.2	0.00466	7.49	400.4704	390.4	3.151885	7572.8	6786	1
7	1.45	44.40	10.63	53.5	126.5	0.00466	3.19	170.4783	403.1	1.341742	5767.4	523	1
8	1.00	44.40	10.63	72.5	126.5	0.00466	2.2	159.3255	278	740.0679	3977.5	361	0
9	72.50	1.38	10.63	36.3	148.7	0.00466	4.95	179.5103	736.4	1586.478	20757	1	2169
10	19.00	1.00	10.63	63.0	104.3	0.00466	0.94	59.24592	98.08	73.67371	389.19	0	28
11	23.90	1.21	10.63	41.6	22.9	0.00466	1.43	59.47283	32.78	227.2023	5336	0	68
12	53.50	1.50	10.63	26.8	0.0	0.00466	3.97	106.251	0	2981.78	27998	1	947
13	53.50	148.70	1.00	26.8	74.4	0.00691	55	1470.492	4087	41267.21	5073.3	101293	13112
14	19.00	44.40	1.00	63.0	126.5	0.00691	5.83	367.2411	737.4	456.673	10550	958	175
15	78.00	104.30	0.50	92.5	52.2	0.00691	28.1	2599.949	1466	41340.79	28436	25481	14251
16	59.00	44.40	0.50	102.0	126.5	0.00691	9.05	923.1649	1145	20723.5	16381	1487	2625
17	80.00	33.00	0.67	112.5	165.2	0.00691	12.2	1375.009	2019	41615.1	80673	1109	6519
18	11.00	20.00	0.50	137.0	138.7	0.00691	0.76	104.1328	105.4	5217.511	2277.9	25	8
19	1.33	148.70	7.75	0.0	74.4	0.00466	7.14	0	530.9	20935.29	658.95	13157	1
20	1.33	22.90	7.75	29.6	11.5	0.00466	1.1	32.54737	12.59	662.6562	5780.7	48	0
21	1.25	125.80	7.75	53.5	85.8	0.00466	5.68	303.7257	487.1	2.39046	19.289	7487	1
22	1.00	15.00	7.75	72.5	111.8	0.00466	0.54	39.26145	60.54	182.3697	419.83	10	0
23	0.83	30.00	7.75	109.0	44.3	0.00466	0.9	97.98575	39.82	2704.626	1413.7	67	0
24	1.00	22.90	7.75	115.2	11.5	0.00466	0.83	95.24124	9.466	3081.482	4346.4	36	0
25	0.86	128.70	7.75	131.5	64.4	0.00466	4	525.4602	257.1	23908.21	1536.1	5516	0
26	1.00	20.00	7.75	142.5	138.7	0.00466	0.72	102.8921	100.1	5636.26	2163.9	24	0
27	72.50	1.12	7.75	36.3	148.7	0.00466	2.93	106.2677	435.9	939.1733	12288	0	1284
28	80.00	1.00	7.75	112.5	148.7	0.00466	2.89	324.9224	429.5	9833.887	12106	0	1540
29	53.50	0.55	7.75	26.8	89.3	0.00466	1.06	28.41694	94.86	797.48	30.33	0	253
30	78.00	0.84	7.75	92.5	59.3	0.00466	2.37	218.8027	140.3	3479.098	1438.1	0	1199
31	22.50	0.65	7.75	120.3	29.3	0.00466	0.53	63.49186	15.47	2307.015	1577.3	0	22
32	23.90	1.21	7.75	41.6	22.9	0.00466	1.04	43.38018	23.91	165.724	3892.1	0	50
33	16.30	1.00	7.75	123.4	22.9	0.00466	0.59	72.58784	13.48	2818.063	2193.8	0	13
34	53.50	1.33	7.75	26.8	0.0	0.00466	2.57	68.71733	0	1928.452	18107	0	613
35	78.00	1.00	7.75	92.5	0.0	0.00466	2.82	260.4794	0	4141.783	19849	0	1428
36	19.00	0.67	7.75	63.0	104.3	0.00466	0.46	28.95383	47.93	36.00478	190.2	0	14
37	11.00	1.00	7.75	137.0	128.7	0.00466	0.4	54.40644	51.11	2726.003	795.03	0	4
38	80.00	1.00	7.75	112.5	181.7	0.00466	2.89	324.9224	524.8	9833.887	27593	0	1540
39							0	0	0	0	0	0	0
40							0	0	0	0	0	0	0
41							0	0	0	0	0	0	0
42							0	0	0	0	0	0	0
43							0	0	0	0	0	0	0
44							0	0	0	0	0	0	0
45							0	0	0	0	0	0	0
46							0	0	0	0	0	0	0
47							0	0	0	0	0	0	0
48							0	0	0	0	0	0	0
49							0	0	0	0	0	0	0
50							0	0	0	0	0	0	0

Total Floor Mass= 208 11247.82 17440 303976.8 359662 202546 49634

C. G. COORDINATES: XCG= 54.15 ft YCG= 83.96 ft Wt.= 6689

MASS MOMENTS OF INERTIA: IXX= 562208 IYY= 353611 IZZ= 915819

Units: Kips, Feet, Second

ICF KAISER
ENGINEERS

Calc S-0001, Rev.0

LANL

SHEET: 131 OF 274

JOB NO: 4452

DATE: 3-1-95

DESIGNED BY: BM

CHECKED BY: SL

DATE: 5/4/95

SUBJECT: --- First Floor (DL+LL)

AS-Build NMSF

ITEM	XD	YD	H	Xc	Yc	m	M	Xc*M	Yc*M	M*X^2	M*Y^2	Ix0	Iy0
1							0	0	0	0	0	0	0
2.1	53.50	20.00	1.00	26.8	138.7	0.01273	13.6	364.448	1890	10227.7	40829	454	3250
3	1.50	148.70	10.63	0.0	74.4	0.00466	11	0	820.8	32370.23	1018.9	20343	2
4	1.00	128.70	10.63	14.8	64.4	0.00466	6.37	94.27675	409.9	9862.977	2448.8	8793	1
5	1.00	128.70	10.63	29.6	64.4	0.00466	6.37	188.5535	409.9	3838.901	2448.8	8793	1
6	1.45	104.30	10.63	53.5	52.2	0.00466	7.49	400.4704	390.4	3.151885	7572.8	6786	1
7	1.45	44.40	10.63	53.5	126.5	0.00466	3.19	170.4783	403.1	1.341742	5767.4	523	1
8	1.00	44.40	10.63	72.5	126.5	0.00466	2.2	159.3255	278	740.0679	3977.5	361	0
9	72.50	1.38	10.63	36.3	148.7	0.00466	4.95	179.5103	736.4	1586.478	20757	1	2169
10	19.00	1.00	10.63	63.0	104.3	0.00466	0.94	59.24592	98.08	73.67371	389.19	0	28
11	23.90	1.21	10.63	41.6	22.9	0.00466	1.43	59.47283	32.78	227.2023	5336	0	68
12	53.50	1.50	10.63	26.8	0.0	0.00466	3.97	106.251	0	2981.78	27998	1	947
13	53.50	148.70	1.00	26.8	74.4	0.01273	101	2709.671	7531	76042.95	9348.6	186652	24161
14	19.00	44.40	1.00	63.0	126.5	0.01273	10.7	676.7139	1359	841.5098	19441	1765	323
15	78.00	104.30	0.50	92.5	52.2	0.02081	84.6	7829.059	4414	124486.9	85626	76728	42912
16	59.00	44.40	0.50	102.0	126.5	0.02081	27.3	2779.867	3448	62403.33	49327	4477	7906
17	80.00	33.00	0.67	112.5	165.2	0.01671	29.6	3325.109	4883	100635.6	195087	2682	15763
18	11.00	20.00	0.50	137.0	138.7	0.02081	2.29	313.5683	317.5	15711.16	6859.2	76	23
19	1.33	148.70	7.75	0.0	74.4	0.00466	7.14	0	530.9	20935.29	658.95	13157	1
20	1.33	22.90	7.75	29.6	11.5	0.00466	1.1	32.54737	12.59	662.6562	5780.7	48	0
21	1.25	125.80	7.75	53.5	85.8	0.00466	5.68	303.7257	487.1	2.39046	19.289	7487	1
22	1.00	15.00	7.75	72.5	111.8	0.00466	0.54	39.26145	60.54	182.3697	419.83	10	0
23	0.83	30.00	7.75	109.0	44.3	0.00466	0.9	97.98575	39.82	2704.626	1413.7	67	0
24	1.00	22.90	7.75	115.2	11.5	0.00466	0.83	95.24124	9.466	3081.482	4346.4	36	0
25	0.86	128.70	7.75	131.5	64.4	0.00466	4	525.4602	257.1	23908.21	1536.1	5516	0
26	1.00	20.00	7.75	142.5	138.7	0.00466	0.72	102.8921	100.1	5636.26	2163.9	24	0
27	72.50	1.12	7.75	36.3	148.7	0.00466	2.93	106.2677	435.9	939.1733	12288	0	1284
28	80.00	1.00	7.75	112.5	148.7	0.00466	2.89	324.9224	429.5	9833.887	12106	0	1540
29	53.50	0.55	7.75	26.8	89.3	0.00466	1.06	28.41694	94.86	797.48	30.33	0	253
30	78.00	0.84	7.75	92.5	59.3	0.00466	2.37	218.8027	140.3	3479.098	1438.1	0	1199
31	22.50	0.65	7.75	120.3	29.3	0.00466	0.53	63.49186	15.47	2307.015	1577.3	0	22
32	23.90	1.21	7.75	41.6	22.9	0.00466	1.04	43.38018	23.91	165.724	3892.1	0	50
33	16.30	1.00	7.75	123.4	22.9	0.00466	0.59	72.58784	13.48	2818.063	2193.8	0	13
34	53.50	1.33	7.75	26.8	0.0	0.00466	2.57	68.71733	0	1928.452	18107	0	613
35	78.00	1.00	7.75	92.5	0.0	0.00466	2.82	260.4794	0	4141.783	19849	0	1428
36	19.00	0.67	7.75	63.0	104.3	0.00466	0.46	28.95383	47.93	36.00478	190.2	0	14
37	11.00	1.00	7.75	137.0	128.7	0.00466	0.4	54.40644	51.11	2726.003	795.03	0	4
38	80.00	1.00	7.75	112.5	181.7	0.00466	2.89	324.9224	524.8	9833.887	27593	0	1540
39							0	0	0	0	0	0	0
40							0	0	0	0	0	0	0
41							0	0	0	0	0	0	0
42							0	0	0	0	0	0	0
43							0	0	0	0	0	0	0
44							0	0	0	0	0	0	0
45							0	0	0	0	0	0	0
46							0	0	0	0	0	0	0
47							0	0	0	0	0	0	0
48							0	0	0	0	0	0	0
49							0	0	0	0	0	0	0
50							0	0	0	0	0	0	0

Total Floor Mass= 359 22208.48 30696 538154.7 600632 344782 105519

C. G. COORDINATES: XCG= 61.90 ft YCG= 85.55 ft Wt.= 11553

MASS MOMENTS OF INERTIA: IXX= 945414 IYY= 643674 IZZ= 1589088

Units: Kips, Feet, Second

ICF KAISER
ENGINEERS

Calc. S-0001, Rev. 0
LANL

SHEET: 132 OF 374

JOB NO.: 41552

DESIGNED BY: BM

DATE:

3-10-75

CHECKED BY: JLV

DATE:

5/9/85

SUBJECT: -First Floor (1.4DL + 1.7LL)

AS-BUILT NMSE

ITEM	XD	YD	H	Xc	Yc	m	M	Xc*M	Yc*M	M*X^2	M*Y^2	Ix0	Iy0
1							0	0	0	0	0	0	0
2.1	53.50	20.00	1.00	26.8	138.7	0.02016	21.6	576.8945	2991	16189.7	64630	719	5144
3	1.50	148.70	10.63	0.0	74.4	0.00652	15.5	0	1149	45318.32	1426.4	28480	3
4	1.00	128.70	10.63	14.8	64.4	0.00652	8.92	131.9874	573.9	13808.17	3428.3	12310	1
5	1.00	128.70	10.63	29.6	64.4	0.00652	8.92	263.9749	573.9	5374.461	3428.3	12310	1
6	1.45	104.30	10.63	53.5	52.2	0.00652	10.5	560.6586	546.5	4.412639	10602	9500	2
7	1.45	44.40	10.63	53.5	126.5	0.00652	4.46	238.6696	564.3	1.878439	8074.3	733	1
8	1.00	44.40	10.63	72.5	126.5	0.00652	3.08	223.0557	389.2	1036.095	5568.5	505	0
9	72.50	1.38	10.63	36.3	148.7	0.00652	6.93	251.3145	1031	2221.069	29060	1	3037
10	19.00	1.00	10.63	63.0	104.3	0.00652	1.32	82.94429	137.3	103.1432	544.86	0	40
11	23.90	1.21	10.63	41.6	22.9	0.00652	2	83.26197	45.89	318.0832	7470.4	0	95
12	53.50	1.50	10.63	26.8	0.0	0.00652	5.56	148.7514	0	4174.492	39197	1	1326
13	53.50	148.70	1.00	26.8	74.4	0.02016	160	4289.211	11922	120370.4	14798	295457	38245
14	19.00	44.40	1.00	63.0	126.5	0.02016	17	1071.189	2151	1332.048	30774	2793	512
15	78.00	104.30	0.50	92.5	52.2	0.03379	137	12713.46	7168	202151.8	139047	124597	69683
16	59.00	44.40	0.50	102.0	126.5	0.03379	44.3	4514.173	5598	101335.6	80101	7270	12838
17	80.00	33.00	0.67	112.5	165.2	0.02687	47.5	5346.922	7852	161826.4	313708	4313	25348
18	11.00	20.00	0.50	137.0	138.7	0.03379	3.72	509.1975	515.5	25513.04	11139	124	37
19	1.33	148.70	7.75	0.0	74.4	0.00652	10	0	743.2	29309.4	922.53	18419	1
20	1.33	22.90	7.75	29.6	11.5	0.00652	1.54	45.56632	17.63	927.7186	8093	67	0
21	1.25	125.80	7.75	53.5	85.8	0.00652	7.95	425.216	681.9	3.346644	27.004	10482	1
22	1.00	15.00	7.75	72.5	111.8	0.00652	0.76	54.96603	84.76	255.3175	587.76	14	0
23	0.83	30.00	7.75	109.0	44.3	0.00652	1.26	137.1801	55.75	3786.476	1979.2	94	0
24	1.00	22.90	7.75	115.2	11.5	0.00652	1.16	133.3377	13.25	4314.074	6085	51	0
25	0.86	128.70	7.75	131.5	64.4	0.00652	5.59	735.6443	360	33471.5	2150.6	7722	0
26	1.00	20.00	7.75	142.5	138.7	0.00652	1.01	144.0489	140.2	7890.764	3029.4	34	0
27	72.50	1.12	7.75	36.3	148.7	0.00652	4.1	148.7747	610.3	1314.843	17203	0	1798
28	80.00	1.00	7.75	112.5	148.7	0.00652	4.04	454.8913	601.3	13767.44	16949	0	2157
29	53.50	0.55	7.75	26.8	89.3	0.00652	1.49	39.78372	132.8	1116.472	42.461	0	355
30	78.00	0.84	7.75	92.5	59.3	0.00652	3.31	306.3238	196.4	4870.737	2013.3	0	1679
31	22.50	0.65	7.75	120.3	29.3	0.00652	0.74	88.8886	21.66	3229.821	2208.3	0	31
32	23.90	1.21	7.75	41.6	22.9	0.00652	1.46	60.73226	33.47	232.0137	5449	0	70
33	16.30	1.00	7.75	123.4	22.9	0.00652	0.82	101.623	18.87	3945.288	3071.3	0	18
34	53.50	1.33	7.75	26.8	0.0	0.00652	3.6	96.20427	0	2699.832	25350	1	858
35	78.00	1.00	7.75	92.5	0.0	0.00652	3.94	364.6712	0	5798.497	27789	0	1999
36	19.00	0.67	7.75	63.0	104.3	0.00652	0.64	40.53536	67.11	50.40669	266.28	0	19
37	11.00	1.00	7.75	137.0	128.7	0.00652	0.56	76.16902	71.55	3816.404	1113	0	6
38	80.00	1.00	7.75	112.5	181.7	0.00652	4.04	454.8913	734.7	13767.44	38630	0	2157
39							0	0	0	0	0	0	0
40							0	0	0	0	0	0	0
41							0	0	0	0	0	0	0
42							0	0	0	0	0	0	0
43							0	0	0	0	0	0	0
44							0	0	0	0	0	0	0
45							0	0	0	0	0	0	0
46							0	0	0	0	0	0	0
47							0	0	0	0	0	0	0
48							0	0	0	0	0	0	0
49							0	0	0	0	0	0	0
50							0	0	0	0	0	0	0

Total Floor Mass= 557 34915.11 47793 835646.9 925956 536000 167462

C. G. COORDINATES: XCG= 62.68 ft YCG= 85.80 ft Wt.= 17935

MASS MOMENTS OF INERTIA: IXX= 1461956 IYY= 1003109 IZZ= 2465065

Units: Kips, Feet, Second

Calc. S-0001, Rev 0

ICF KAISER
ENGINEERS

LANL

SHEET: 135 OF 274

JOB NO: 41552

DESIGNED BY: BM DATE: 3/1/95

SUBJECT: --- Roof Mass

CHECKED BY: J DATE: 5/4/95

~~AS-Build~~ NMSF

ITEM	XD	YD	H	Xc	Yc	m	M	Xc*M	Yc*M	M*X ²	M*Y ²	Ix0	Iy0
1							0	0	0	0	0	0	0
2							0	0	0	0	0	0	0
3							0	0	0	0	0	0	0
4							0	0	0	0	0	0	0
5							0	0	0	0	0	0	0
6							0	0	0	0	0	0	0
7							0	0	0	0	0	0	0
8							0	0	0	0	0	0	0
9							0	0	0	0	0	0	0
10							0	0	0	0	0	0	0
11							0	0	0	0	0	0	0
12							0	0	0	0	0	0	0
13							0	0	0	0	0	0	0
14							0	0	0	0	0	0	0
15							0	0	0	0	0	0	0
16							0	0	0	0	0	0	0
17							0	0	0	0	0	0	0
18							0	0	0	0	0	0	0
19	1.33	148.70	7.75	0.0	74.4	0.00466	7.14	0	530.9	24627.5	322.03	13157	1
20	1.33	22.90	7.75	29.6	11.5	0.00466	1.1	32.54737	12.59	933.0534	5328.9	48	0
21	1.25	125.80	7.75	53.5	85.8	0.00466	5.68	303.7257	487.1	155.2882	127.24	7487	1
22	1.00	15.00	7.75	72.5	111.8	0.00466	0.54	39.26145	60.54	102.6818	511.53	10	0
23	0.83	30.00	7.75	109.0	44.3	0.00466	0.9	97.98575	39.82	2271.713	1215.1	67	0
24	1.00	22.90	7.75	115.2	11.5	0.00466	0.83	95.24124	9.466	2636.377	4006.7	36	0
25	0.86	128.70	7.75	131.5	64.4	0.00466	4	525.4602	257.1	21160.13	1116.5	5516	0
26	1.00	20.00	7.75	142.5	138.7	0.00466	0.72	102.8921	100.1	5066.916	2398.4	24	0
27	72.50	1.12	7.75	36.3	148.7	0.00466	2.93	106.2677	435.9	1481.451	13410	0	1284
28	80.00	1.00	7.75	112.5	148.7	0.00466	2.89	324.9224	429.5	8350.384	13212	0	1540
29	53.50	0.55	7.75	26.8	89.3	0.00466	1.06	28.41694	94.86	1086.455	72.028	0	253
30	78.00	0.84	7.75	92.5	59.3	0.00466	2.37	218.8027	140.3	2697.565	1120.6	0	1199
31	22.50	0.65	7.75	120.3	29.3	0.00466	0.53	63.49186	15.47	1998.32	1414.9	0	22
32	23.90	1.21	7.75	41.6	22.9	0.00466	1.04	43.38018	23.91	308.1548	3532.3	0	50
33	16.30	1.00	7.75	123.4	22.9	0.00466	0.59	72.58784	13.48	2457.299	1990.9	0	13
34	53.50	1.33	7.75	26.8	0.0	0.00466	2.57	68.71733	0	2627.245	16882	0	613
35	78.00	1.00	7.75	92.5	0.0	0.00466	2.82	260.4794	0	3211.387	18506	0	1428
36	19.00	0.67	7.75	63.0	104.3	0.00466	0.46	28.95383	47.93	8.379389	248.1	0	14
37	11.00	1.00	7.75	137.0	128.7	0.00466	0.4	54.40644	51.11	2432.876	901.09	0	4
38	80.00	1.00	7.75	112.5	181.7	0.00466	2.89	324.9224	524.8	8350.384	29250	0	1540
39	53.5	148.7	1	26.75	74.4	0.01183	94.1	2518.011	6999	96270.22	4245.5	173450	22452
40	78	148.7	0.86	92.5	74.4	0.00578	57.6	5331.034	4285	65725.01	2599.3	106197	29220
41	80	33	0.86	112.5	165	0.00578	13.1	1475.776	2167	37926.91	92857	1190	6996
42							0	0	0	0	0	0	0
43							0	0	0	0	0	0	0
44							0	0	0	0	0	0	0
45							0	0	0	0	0	0	0
46							0	0	0	0	0	0	0
47							0	0	0	0	0	0	0
48							0	0	0	0	0	0	0
49							0	0	0	0	0	0	0
50							0	0	0	0	0	0	0

Total Floor Mass=	206	12117.28	16726	291885.7	215267	307184	66632
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C. G. COORDINATES:	XCG= 58.73 ft	YCG=	81.07 ft	Wt.=	6644
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MASS MOMENTS OF INERTIA:	IXX=	522450	IYY=	358517	IZZ=	880968
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Units: Kips, Feet, Second

ICF KAISER
ENGINEERS

LANL

SHEET: 134 OF 274

JOB NO.: 41752

DATE: 3-1-95

DESIGNED BY: BM

CHECKED BY: JL

DATE: 5/4/95

SUBJECT: ---Roof (DL+LL)

AS-BUILT NMST 0 LANL

ITEM	XD	YD	H	Xc	Yc	m	M	Xc*M	Yc*M	M*X^2	M*Y^2	Ix0	Iy0
1							0	0	0	0	0	0	0
2							0	0	0	0	0	0	0
3							0	0	0	0	0	0	0
4							0	0	0	0	0	0	0
5							0	0	0	0	0	0	0
6							0	0	0	0	0	0	0
7							0	0	0	0	0	0	0
8							0	0	0	0	0	0	0
9							0	0	0	0	0	0	0
10							0	0	0	0	0	0	0
11							0	0	0	0	0	0	0
12							0	0	0	0	0	0	0
13							0	0	0	0	0	0	0
14							0	0	0	0	0	0	0
15							0	0	0	0	0	0	0
16							0	0	0	0	0	0	0
17							0	0	0	0	0	0	0
18							0	0	0	0	0	0	0
19	1.33	148.70	7.75	0.0	74.4	0.00466	7.14	0	530.9	24627.5	322.03	13157	1
20	1.33	22.90	7.75	29.6	11.5	0.00466	1.1	32.54737	12.59	933.0534	5328.9	48	0
21	1.25	125.80	7.75	53.5	85.8	0.00466	5.68	303.7257	487.1	155.2882	127.24	7487	1
22	1.00	15.00	7.75	72.5	111.8	0.00466	0.54	39.26145	60.54	102.6818	511.53	10	0
23	0.83	30.00	7.75	109.0	44.3	0.00466	0.9	97.98575	39.82	2271.713	1215.1	67	0
24	1.00	22.90	7.75	115.2	11.5	0.00466	0.83	95.24124	9.466	2636.377	4006.7	36	0
25	0.86	128.70	7.75	131.5	64.4	0.00466	4	525.4602	257.1	21160.13	1116.5	5516	0
26	1.00	20.00	7.75	142.5	138.7	0.00466	0.72	102.8921	100.1	5066.916	2398.4	24	0
27	72.50	1.12	7.75	36.3	148.7	0.00466	2.93	106.2677	435.9	1481.451	13410	0	1284
28	80.00	1.00	7.75	112.5	148.7	0.00466	2.89	324.9224	429.5	8350.384	13212	0	1540
29	53.50	0.55	7.75	26.8	89.3	0.00466	1.06	28.41694	94.86	1086.455	72.028	0	253
30	78.00	0.84	7.75	92.5	59.3	0.00466	2.37	218.8027	140.3	2697.565	1120.6	0	1199
31	22.50	0.65	7.75	120.3	29.3	0.00466	0.53	63.49186	15.47	1998.32	1414.9	0	22
32	23.90	1.21	7.75	41.6	22.9	0.00466	1.04	43.38018	23.91	308.1548	3532.3	0	50
33	16.30	1.00	7.75	123.4	22.9	0.00466	0.59	72.58784	13.48	2457.299	1990.9	0	13
34	53.50	1.33	7.75	26.8	0.0	0.00466	2.57	68.71733	0	2627.245	16882	0	613
35	78.00	1.00	7.75	92.5	0.0	0.00466	2.82	260.4794	0	3211.387	18506	0	1428
36	19.00	0.67	7.75	63.0	104.3	0.00466	0.46	28.95383	47.93	8.379389	248.1	0	14
37	11.00	1.00	7.75	137.0	128.7	0.00466	0.4	54.40644	51.11	2432.876	901.09	0	4
38	80.00	1.00	7.75	112.5	181.7	0.00466	2.89	324.9224	524.8	8350.384	29250	0	1540
39	53.5	148.7	1	26.75	74.4	0.01211	96.4	2577.492	7164	98544.32	4345.8	177547	22983
40	78	148.7	0.86	92.5	74.4	0.00612	61	5644.898	4537	69594.57	2752.4	112449	30940
41	80	33	0.86	112.5	165	0.00612	13.9	1562.663	2295	40159.85	98324	1261	7408
42							0	0	0	0	0	0	0
43							0	0	0	0	0	0	0
44							0	0	0	0	0	0	0
45							0	0	0	0	0	0	0
46							0	0	0	0	0	0	0
47							0	0	0	0	0	0	0
48							0	0	0	0	0	0	0
49							0	0	0	0	0	0	0
50							0	0	0	0	0	0	0

Total Floor Mass= 213 12577.52 17271 300262.3 220987 317603 69294

C. G. COORDINATES: XCG= 59.13 ft YCG= 81.19 ft Wt.= 6849

MASS MOMENTS OF INERTIA: IXX= 538590 IYY= 369556 IZZ= 908147

Units: Kips, Feet, Second

ICF KAISER
ENGINEERS

LANL

SHEET: 135 OF 274

JOB NO.: 00262

DESIGNED BY: BM DATE: 3-10-95

CHECKED BY: JV DATE: 5/4/95

SUBJECT: -Roof (1.4DL + 1.7LL)

AS - BUILT NMSF

ITEM	XD	YD	H	Xc	Yc	m	M	Xc*M	Yc*M	M*X ²	M*Y ²	Ix0	Iy0
1							0	0	0	0	0	0	0
2							0	0	0	0	0	0	0
3							0	0	0	0	0	0	0
4							0	0	0	0	0	0	0
5							0	0	0	0	0	0	0
6							0	0	0	0	0	0	0
7							0	0	0	0	0	0	0
8							0	0	0	0	0	0	0
9							0	0	0	0	0	0	0
10							0	0	0	0	0	0	0
11							0	0	0	0	0	0	0
12							0	0	0	0	0	0	0
13							0	0	0	0	0	0	0
14							0	0	0	0	0	0	0
15							0	0	0	0	0	0	0
16							0	0	0	0	0	0	0
17							0	0	0	0	0	0	0
18							0	0	0	0	0	0	0
19	1.33	148.70	7.75	0.0	74.4	0.00652	10	0	743.2	34478.5	450.84	18419	1
20	1.33	22.90	7.75	29.6	11.5	0.00652	1.54	45.56632	17.63	1306.275	7460.5	67	0
21	1.25	125.80	7.75	53.5	85.8	0.00652	7.95	425.216	681.9	217.4034	178.14	10482	1
22	1.00	15.00	7.75	72.5	111.8	0.00652	0.76	54.96603	84.76	143.7545	716.14	14	0
23	0.83	30.00	7.75	109.0	44.3	0.00652	1.26	137.1801	55.75	3180.398	1701.2	94	0
24	1.00	22.90	7.75	115.2	11.5	0.00652	1.16	133.3377	13.25	3690.927	5609.4	51	0
25	0.86	128.70	7.75	131.5	64.4	0.00652	5.59	735.6443	360	29624.18	1563.1	7722	0
26	1.00	20.00	7.75	142.5	138.7	0.00652	1.01	144.0489	140.2	7093.682	3357.8	34	0
27	72.50	1.12	7.75	36.3	148.7	0.00652	4.1	148.7747	610.3	2074.032	18774	0	1798
28	80.00	1.00	7.75	112.5	148.7	0.00652	4.04	454.8913	601.3	11690.54	18496	0	2157
29	53.50	0.55	7.75	26.8	89.3	0.00652	1.49	39.78372	132.8	1521.037	100.84	0	355
30	78.00	0.84	7.75	92.5	59.3	0.00652	3.31	306.3238	196.4	3776.591	1568.9	0	1679
31	22.50	0.65	7.75	120.3	29.3	0.00652	0.74	88.8886	21.66	2797.648	1980.8	0	31
32	23.90	1.21	7.75	41.6	22.9	0.00652	1.46	60.73226	33.47	431.4167	4945.2	0	70
33	16.30	1.00	7.75	123.4	22.9	0.00652	0.82	101.623	18.87	3440.219	2787.3	0	18
34	53.50	1.33	7.75	26.8	0.0	0.00652	3.6	96.20427	0	3678.143	23634	1	858
35	78.00	1.00	7.75	92.5	0.0	0.00652	3.94	364.6712	0	4495.942	25908	0	1999
36	19.00	0.67	7.75	63.0	104.3	0.00652	0.64	40.53536	67.11	11.73114	347.34	0	19
37	11.00	1.00	7.75	137.0	128.7	0.00652	0.56	76.16902	71.55	3406.026	1261.5	0	6
38	80.00	1.00	7.75	112.5	181.7	0.00652	4.04	454.8913	734.7	11690.54	40949	0	2157
39	53.5	148.7	1	26.75	74.4	0.01724	137	3667.969	10195	140236.1	6184.4	252664	32706
40	78	148.7	0.86	92.5	74.4	0.00888	88.6	8195.131	6587	101035.8	3995.8	163251	44918
41	80	33	0.86	112.5	165	0.00888	20.2	2268.637	3331	58303.13	142744	1830	10755
42							0	0	0	0	0	0	0
43							0	0	0	0	0	0	0
44							0	0	0	0	0	0	0
45							0	0	0	0	0	0	0
46							0	0	0	0	0	0	0
47							0	0	0	0	0	0	0
48							0	0	0	0	0	0	0
49							0	0	0	0	0	0	0
50							0	0	0	0	0	0	0

Total Floor Mass= 304 18041.19 24698 428324 314715 454630 99528

C. G. COORDINATES: XCG= 59.37 ft YCG= 81.27 ft Wt.= 9786

MASS MOMENTS OF INERTIA: IXX= 769345 IYY= 527852 IZZ= 1297197

Units: Kips, Feet, Second

1st Floor
514B

NMSF0
UNDEFORMED
SHAPE

OPTIONS
ALL JOINTS
WIRE FRAME

SAP90

NMSF0
UNDEFORMED
SHAPE

OPTIONS
ALL JOINTS
WIRE FRAME

SAP90

841.141.4 274
 Job 41552
 calc S-0001

SECTION 'b'

SECTION 'a'

EVALUATION of NMSF - LANE
AS - BUILTDESIGNED BY BM DATE 1/5/95
CHECKED BY TL DATE 5/18/95

check Spread sheet:

C.G.: $X_{CG} = 7.5$ $Y_{CG} = 5$
 Mass Mom: $I_{xx} = 15 \times 10^3 / 12 \times 0.15 = 187.5$
 $I_{yy} = 10 \times 15^3 / 12 \times 0.15 = 421.88$
 $W = 10 \times 15 \times 0.15 = 22.5 \text{ k}$

ITEM NO.

$$X_{CG} = 7.5$$

$$Y_{CG} = 5$$

See spread sheet Printouts
on next sheets.

SPREAD SHEET FORMULATION

$$W = x_D \cdot y_D \cdot H \cdot w$$

$$I_{x0} = w \cdot H \cdot x_D \cdot y_D^3 / 12$$

w = weight density (0.15 KCF for Conc.)
 H = thickness for slabs
 ($1/2$) wall heights for walls

$$I_{y0} = w \cdot H \cdot y_D \cdot x_D^3 / 12$$

$$X_{CG} = \frac{\sum_{i=1}^n W_i \cdot X_{Ci}}{\sum_{i=1}^n W_i}$$

$$Y_{CG} = \frac{\sum_{i=1}^n W_i \cdot Y_{Ci}}{\sum_{i=1}^n W_i}$$

$$I_{xx} = \sum_{i=1}^n (I_{x0})_i + \sum W_i \cdot (Y_{Ci} - Y_{CG})^2$$

$$I_{yy} = \sum (I_{y0})_i + \sum W_i \cdot (X_{Ci} - X_{CG})^2$$

$$I_{zz} = I_{xx} + I_{yy}$$

ICF KAISER
ENGINEERS LANL

Calc. S-0001, Rev. 0

SHEET: 143 OF 271
JOB NO.: 41552
DATE: 3-1-57
DATE: 5/15/95

DESIGNED BY: Bm

CHECKED BY: JV

AS-Built NMSE

ITEM	XD	YD	H	Xc	Yc	W	Xc*W	Yc*W	W*X^2	W*Y^2	Ix0	Iy0
1	7	8	1	3.5	6	8.4	29.4	50.4	134.4	8.4	44.8	34.3
2	8	4	1	11	8	4.8	52.8	38.4	58.8	43.2	6.4	25.6
3	8	6	1	11	3	7.2	79.2	21.6	88.2	28.8	21.6	38.4
4	7	2	1	3.5	1	2.1	7.35	2.1	33.6	33.6	0.7	8.575
5						0	0	0	0	0	0	0
6						0	0	0	0	0	0	0
7						0	0	0	0	0	0	0
8						0	0	0	0	0	0	0
9						0	0	0	0	0	0	0
10						0	0	0	0	0	0	0
11						0	0	0	0	0	0	0
12						0	0	0	0	0	0	0
13						0	0	0	0	0	0	0
14						0	0	0	0	0	0	0
15						0	0	0	0	0	0	0
16						0	0	0	0	0	0	0
17						0	0	0	0	0	0	0
18						0	0	0	0	0	0	0
19						0	0	0	0	0	0	0
20						0	0	0	0	0	0	0
21						0	0	0	0	0	0	0
22						0	0	0	0	0	0	0
23						0	0	0	0	0	0	0
24						0	0	0	0	0	0	0
25						0	0	0	0	0	0	0
26						0	0	0	0	0	0	0
27						0	0	0	0	0	0	0
27						0	0	0	0	0	0	0
28						0	0	0	0	0	0	0
29						0	0	0	0	0	0	0
30						0	0	0	0	0	0	0
UNITS: K,F,S UNIT WT: 0.15 KCF 22.5 168.75 112.5 315 114 73.5 106.88												
C. G. COORDINATES: XCG= 7.50 YCG= 5.00												
MASS MOMENTS OF INERTIA: IXX= 188 IYY= 422 IZZ= 609												

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LANL

Calc. S-0001, Rev. 0

SHEET:

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JOB NO.:

41952

DATE:

3-1-95

DATE:

5/15/95

DESIGNED BY:

BM

CHECKED BY:

IL

AS-Build

ITEM	XD	YD	H	Xc	Yc	W	Xc*W	Yc*W	W*X^2	W*Y^2	Ix0	Iy0	
1	15	10	1	7.5	5	22.5	168.75	112.5	0	0	187.5	421.88	
2						0	0	0	0	0	0	0	
3						0	0	0	0	0	0	0	
4						0	0	0	0	0	0	0	
5						0	0	0	0	0	0	0	
6						0	0	0	0	0	0	0	
7						0	0	0	0	0	0	0	
8						0	0	0	0	0	0	0	
9						0	0	0	0	0	0	0	
10						0	0	0	0	0	0	0	
11						0	0	0	0	0	0	0	
12						0	0	0	0	0	0	0	
13						0	0	0	0	0	0	0	
14						0	0	0	0	0	0	0	
15						0	0	0	0	0	0	0	
16						0	0	0	0	0	0	0	
17						0	0	0	0	0	0	0	
18						0	0	0	0	0	0	0	
19						0	0	0	0	0	0	0	
20						0	0	0	0	0	0	0	
21						0	0	0	0	0	0	0	
22						0	0	0	0	0	0	0	
23						0	0	0	0	0	0	0	
24						0	0	0	0	0	0	0	
25						0	0	0	0	0	0	0	
26						0	0	0	0	0	0	0	
27						0	0	0	0	0	0	0	
27						0	0	0	0	0	0	0	
28						0	0	0	0	0	0	0	
29						0	0	0	0	0	0	0	
30						0	0	0	0	0	0	0	
UNITS: K,F,S				UNIT WT:		0.15 KCF	22.5	168.75	112.5	0	0	187.5	421.88
C. G. COORDINATES:						XCG=	7.50	YCG=	5.00				
MASS MOMENTS OF INERTIA:						IXX=	188	IYY=	422	IZZ=	609		

EVALUATION OF NMSE WALL
AS-BUILT

DESIGNED BY BM DATE 3/10/9

CHECKED BY JV DATE 5/15/1

LATERAL SOIL PRESSURE

Lateral Soil Pressures are applied to 3-D model to account for in-plane forces in the shear walls due to lateral soil pressure.

The lateral soil pressure patterns are similar for west, north and south walls.

Soil Pressures are applied west wall and north wall neglecting the passive soil pressures on the south and east walls, Conservatively.

Analysis is performed only for load cases that generated maximum moments and shears in 2-D analysis of the wall sections.

2) OPTION-1 (NMSF05)

STATIC

DYNAMIC

Pressure profile Applied to West and North walls.
1) AS-BUILT (NMSF41)...

STATIC/DYNAMIC lateral soil pressure (AS-IS)

NMSF21
UNDEFORMED
SHAPE

OPTIONS
JOINT IDS
WIRE FRAME

SAP90

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ENGINEERS**

Calc. No. S-0001 Rev. 0

JOB NO. 41552
SHEET 129 OF 274

LANL

STRUCTURAL EVALUATION OF NMSF FACILITY AT LANL

DESIGNED BY B. Mosaddad DATE 3/10/95

As-Built Structure

CHECKED BY JL DATE 5/15/98

5.3 SOIL-STRUCTURE-INTERACTION EFFECTS

EVALUATION OF NMSE @ CAM

AS-BUILT

DESIGNED BY B. MacLeod DATE 3/10/92

CHECKED BY JV DATE 5/18/94

Foundation Spring Constants Summary

BUILDING	K_x (K/ft)	K_y (K/ft)	K_z (K/ft)	K_{xx} (K-ft/Rad)	K_{yy} ()	K_{zz} ()
MAA	317 G	300 G	214 G	2.53×10^6 G	1.25×10^6 G	1.6×10^7 G
ADMIN	259 G	272 G	340 G	3.67×10^5 G	2.15×10^6 G	1.15×10^6 G
I) $G = 6.11 \times 10^3$ KSF						
MAA	1.94×10^6	1.83×10^6	1.31×10^6	1.55×10^{10}	7.64×10^9	9.78×10^{10}
ADMIN	1.58×10^6	1.66×10^6	2.08×10^6	2.24×10^9	1.31×10^{10}	7.03×10^9

G.G. Coordinates:

MAA: $\bar{x} = 31.4'$ $\bar{y} = 80.6'$

ADMIN: $\bar{x} = 55 + 40.5 = 95.5'$

$\bar{y} = 90.4'$

EVALUATION OF NMSE AT LANL
AS-BUILT

DESIGNED BY B. Musaddad DATE 7/10/95

CHECKED BY JV DATE 5/18/96

A-A

EVALUATION OF NMSF @

AS-BUILT STRUCTURE CAUL

DESIGNED BY B. Masadad DATE 3/1/92

CHECKED BY JV

DATE 5/15/93

Soil Spring & Dashpot Constants

Procedure:

- 1) Break up NMSF Building into Two segment into the MAA (Western portion) and ADMIN (Eastern portion)
- 2) Assume MAA To be Embedded below 1st Floor. (Neglecting Partial Embedment @ 3 sides of 1st floor walls)
- 3) Assume ADMIN part To be surface founded.
- 4) Compute Two sets of Spring & Dashpots for ADMIN & MAA.

1) FOUNDATION PROPERTIES (M.A.)

- The 18" Mat Foundation is assumed to be rigid and whole building Area is used to calculate geometric constants:

$$A = 55 \times 150 + 22 \times 44$$

$$= 9218 \text{ sq'}$$

$$\bar{X} = \frac{(55 \times 150) \left(\frac{55}{2} + (22 \times 44) \left(\frac{55}{55+22} \right) \right)}{9218}$$

$$\bar{X} = 31.44'$$

$$\bar{Y} = \frac{(55 \times 150) \left(\frac{150}{2} + (22 \times 44) \left(\frac{150+106}{2} \right) \right)}{9218}$$

$$\bar{Y} = 80.57'$$

$$55' \times 22'$$

$$I_{yy} = \frac{55 \times 150^3}{12} + \frac{22 \times 44^3}{12} + (55 \times 150) (75 - 80.57)^2 + (44 \times 22) \left(\frac{150+106}{2} - 80.57 \right)^2$$

$$= 18,058,494 + 156,171 + 255,955 + 2,177,618$$

$$= 18,058,494 + 156,171 + 255,955 + 2,177,618$$

$$= 20,79,688 + 39,043 + 128,070 + 48,249 = 2,295,048$$

$$I_{xx} = \frac{150 \times 55^3}{12} + \frac{44 \times 22^3}{12} + (150 \times 55) \left(\frac{55}{2} - 31.44 \right)^2 + (44 \times 22) \left(\frac{55+22}{2} - 31.44 \right)^2$$

EVALUATION OF NAIF AT
LANE
AS-BUILT STRUCTURE

DESIGNED BY BMos added DATE 3/10/92
CHECKED BY JV DATE 5/15/95

Equivalent Rectangle

• Vertical

$$A = 9218 \text{ FT}^2$$

$$B = 150'$$

$$L = 9218/150 = \underline{61.5'}$$

• Rocking About xx Axis

$$I_{xx} = 2,295,048$$

$$B = 150$$

$$\frac{BL^3}{12} = I_{xx} \longrightarrow L = \left(\frac{12 I_{xx}}{B} \right)^{1/3} = \underline{56.8'}$$

• Rocking About Y-Y Axis

$$I_{yy} = 188,214,744$$

$$\cancel{B} = \cancel{150'}$$

$$\cancel{B} = \left(\frac{12 I_{yy}}{\cancel{L}} \right)^{1/3} =$$

$$\cancel{L} = 150$$

$$B = \left(12 I_{yy} / \cancel{L} \right)^{1/3} = \underline{113.0'}$$

• Horizontal Translation

x-dir $B = \cancel{61.5'} \quad L = 150'$

y-dir $B = 150' \quad L = \cancel{61.5'}$

• Torsion

$B = 61.5' \quad L = 150'$

EVALUATION OF NMSF AT

LANL

AS-BUILT STRUCTURE

DESIGNED BY BMosadad DATE 3/10/95

CHECKED BY JV DATE 5/5/95

Spring Constants (MAA)

REF: ASCE 4-86
Table 3300-2

Horizontal $K_x = 2(1+\nu) G \beta_x \sqrt{BL}$

Rocking $K_y = \frac{G}{(1-\nu)} \beta_y BL^2$

Vertical $K_z = \frac{G}{1-\nu} \beta_z \sqrt{BL}$

Torsion $K_t = 16GR^3/3$, $R = \sqrt[4]{BL(B^2+L^2)/6\pi}$

USE : $\rho = 3.37 \text{ lb. s}^2/\text{ft}^4$

$\nu = 0.35$

best estimate $\rightarrow G_1 = 6.11 \times 10^6 \text{ psf}$

$G_2 = 1/2 G_1 = 3.06 \times 10^6 \text{ psf}$

$G_3 = 2 G_1 = 1.22 \times 10^7 \text{ psf}$

Equivalent Half-Space
Soil Properties
from calculation
by Goen for
PF-4 structure

• HORIZONTAL

x-direction

$B = 61.5'$ $L = 150$

$B/L = 2.4 \rightarrow \beta_x = 1.0$

$K_x = 2(1+0.35) G (1.0) \sqrt{61.5 \times 150}$
 $= 259.3 G$

y-direction

$B = 150$ $L = 61.5$

$L/B = 61.5/150 = 0.41 \rightarrow \beta = 1.05$

$K_x = 2(1.35) G (1.05) \sqrt{61.5 \times 150}$
 $= 272.3 G$

EVALUATION OF NMSF
LANL

AS-BUILT STRUCTURE

DESIGNED BY B Mosaddad DATE 3/10/92

CHECKED BY JV DATE 5/15/92

• Rocking

About x-x

$$\begin{aligned}
 B &= 150 & L &= 61.5 \\
 L/B &= 0.41 & \longrightarrow & \beta_r = 0.42 \\
 K_{xx} &= \frac{G}{1-.35} \times 0.42 \times 150 \times 61.5^2 \\
 &= 3.67 \times 10^5 G
 \end{aligned}$$

About y-y

$$\begin{aligned}
 B &= 113 & L &= 150 \\
 L/B &= 1.33 & \longrightarrow & \beta_r = 0.55 \\
 K_{yy} &= \frac{G}{1-.35} \times 0.55 \times 113 \times 150^2 \\
 &= 2.15 \times 10^6 G
 \end{aligned}$$

• Vertical

$$\begin{aligned}
 B &= 61.5 & L &= 150 \\
 L/B &= 2.44 & \longrightarrow & \beta_z = 2.3 \\
 K_z &= \frac{G}{1-.35} \times 2.3 \times \sqrt{61.5 \times 150} \\
 &= 340. G
 \end{aligned}$$

• Torsion

$$R = \sqrt[4]{61.5 \times 150 (61.5^2 + 150^2) / 6\pi} = 59.9 \text{ FT.}$$

$$\begin{aligned}
 K_{\frac{\pi}{2}} &= 16 \times G \times R^3 / 3 \\
 &= 1.15 \times 10^6 G
 \end{aligned}$$

Evaluation of NMSF @

CAUL

AS-BUILT STRUCTURE

DESIGNED BY B Mesudde DATE 3/10/93

CHECKED BY JV

DATE 5/5/93

Damping Constants (MAA) REF: ASCE 4-86

Horizontal

$$C_x = 0.576 k_x R \sqrt{P/G}, R = \sqrt{BL/\pi}$$

Rocking

$$C_\gamma = \frac{0.30}{1 + \beta_\gamma} k_\gamma R \sqrt{P/G}, R = \sqrt[4]{BL^3/3\pi}$$

Vertical

$$C_z = 0.85 k_z R \sqrt{P/G}, R = \sqrt{BL/\pi}$$

Torsion

$$C_t = \frac{\sqrt{k_t i_t}}{1 + 2 I_t / (P R^5)}, R = \sqrt[4]{BL^3/3\pi}$$

where:

$$\beta_\gamma = \frac{3(1-\nu) I_o}{8 P R^5}$$

 I_o = Total Mass Moment of Inertia of Structure I_t = " Polar " " " " " "

Evaluation of NMSF @ CANL

42- EXIST STRUCTURE

DESIGNED BY B. Mesaddad DATE 3/10/95

CHECKED BY J ✓

DATE 7/15/95

2) FOUNDATION PROPERTIES (ADMIN)

- Assume Rigid slab

$$A = 80 \times 33 + 49 \times 44 + 71 \times 106$$

$$= 12,322 \text{ FT}^2$$

$$\bar{X} = \frac{(80 \times 33)(50) + (49 \times 44)(22 + \frac{49}{2})}{12,322}$$

$$+ \frac{(71 \times 106)(71/2)}{12,322} =$$

$$\bar{X} = \frac{2640 \times 50 + 2156 \times 46.5 + 7526 \times 35.5}{12,322}$$

$$= 40.5 \text{ FT.}$$

$$\bar{Y} = \frac{2640 \times (150 + \frac{33}{2}) + 2156(106 + \frac{44}{2})}{12,322}$$

$$+ \frac{7526(106/2)}{12,322}$$

$$\bar{Y} = 90.4$$

$$I_{xx} = \frac{80 \times 33^3}{12} + 49 \times \frac{44^3}{12} + 71 \times \frac{106^3}{12}$$

$$+ 2640 \left(150 + \frac{33}{2} - 90.4\right)^2 + 2156 \left(106 + \frac{44}{2} - 90.4\right)^2 + 7526 (53 - 90.4)^2$$

$$I_{xx} = 1,408,000 + 347,835 + 7,046,845$$

$$+ 15,288,794 + 3,048,067 + 10,527,068$$

$$= \frac{3.167 \times 10^7}{3.650} \text{ FT}^4$$

EVALUATION of NMSF

AS BUILT STRUCTURE

DESIGNED BY B Masadda DATE 7/10/9.

CHECKED BY JV DATE 7/15/95

$$\begin{aligned}
 I_{yy} &= 33 \times 80^3 / 12 + 44 \times 49^3 / 12 + 106 \times 71^3 / 12 \\
 &+ (33 \times 80)(10 + 40 - 40.5)^2 + (44 \times 49)(22 + 49/2 - 40.5)^2 + 106 \times 71 \times (71/2)^2 \\
 &= 1,408,000 + 431,380 + 3,161,547 \\
 &+ 238,260 + 77,616 + 9,484,642 = \\
 &= 1.480 \times 10^7
 \end{aligned}$$

Equivalent Rectangular Dimensions

Vertical:

$$A = 12,322$$

$$B = 71'$$

$$L = 12,322 / 71 = 173.6'$$

Rocking:

ABOUT X-X Axis

$$B = 183'$$

$$L = (12 I_{xx} / B)^{1/3}$$

$$= (12 \times 3.65 \times 10^7 / 183)^{1/3} = 134'$$

ABOUT Y-Y Axis

$$B = 71'$$

$$L = (12 I_{yy} / B)^{1/3}$$

$$= (12 \times 1.48 \times 10^7 / 71)^{1/3} = 136'$$

ICF KAISER ENGINEERS

Calc S-0001 Rev. 0

Evaluation of NMSF

Job No. 41552
SHEET 130 OF 271

DESIGNED BY S. Masadood DATE 10/95
CHECKED BY JL DATE 5/15/95

Horizontal Translation

X-Direction

$$B = 183, L = \frac{12322}{183} = 67.3$$

Y-Direction

$$B = 71, L = 174$$

Spring Constants

Horizontal

X-Direction

$$K_x = 2(1+0.35)G(1.06) / \sqrt{183 \times 67} = 318.9$$

$$L/B = 0.37 \rightarrow \beta_x = 1.06$$

Y-Direction

$$L/B = 174/71 = 2.5 \rightarrow \beta_x = 1.0$$

$$K_x = 2(1+0.35)G(1.0) / \sqrt{174 \times 71} = 300.9$$

Rocking

About X-X

$$B = 183, L = 134$$

$$L/B = 0.7 \rightarrow \beta_x = 0.5$$

$$K_{rx} = \frac{G}{1+0.35} \times 0.60 \times 183 \times 134^2 = 2.53 \times 10^6$$

Evaluation of NMSF @ LANL

DESIGNED BY B. M. Suddud DATE 3/18/98

AS-BUILT STRUCTURE

CHECKED BY JL

DATE 5/18/98

ABOUT Y-Y Axis

$$B = \frac{71}{12} \quad L = 136' \quad 136'$$

$$L/B = 136/71 = 1.92 \rightarrow \beta_p = 0.62$$

$$K_{YY} = \frac{G}{1 - 0.35} \times 0.62 \times 71 \times 136^2$$

$$= 1.25 \times 10^6$$

Vertical:

$$L/B = 173.6/71 = 2.45 \rightarrow \beta_2 = 1.25$$

$$K_2 = \frac{G}{1 - 0.35} \times 1.25 \sqrt{173.6 \times 71}$$

$$= 214 G$$

TORSION:

$$R = \sqrt[4]{173.6 \times 71 (173.6^2 + 71^2) / 6\pi} = 144.3 \text{ FT.}$$

$$K_T = 16 G R^3 / 3$$

$$= 1.60 \times 10^7 G$$

Evaluation of NMSE @ CANL

DESIGNED BY Bm.

DATE 1/3/95

AS-BUILT STRUCTURE

CHECKED BY JV

DATE 5/15/95

Embedment Effects

Compute an equivalent Embedment.

Assume:

- MAA Portion Embedment only 1/2 effective above 1st Floor. This is a conservative assumption with respect to computation of soil springs where the embedment above 1st Floor was ignored (ASCE 4-86)
- Use an equivalent Embedment depth
- Compute soil spring stiffness multipliers, K_{sx} "SSI in Time Domain" By J.P. WOLF (1988, Sec 2.7)

$$\frac{P}{F_{Rx}} = 1 + \left(.33 + \frac{1.34}{1 + e/b} \right) \left(\frac{e}{b} \right)^{0.8}$$

where:

 e = Embedment depth. b = Foundation width l = " length (along x-axis)

Blg. Position	Area (FT ²)	Embedment, e
MAA	9218	$21 + 1/2(15.5) = 28.75$
ADMIN	12,322	0
TOTAL	21,540	$e \approx 12.3$ FT.

Evaluation of NMSF 2

LAAL
AS-BUILT STRUCTURE

DESIGNED BY AM

DATE 1/3/95

CHECKED BY JL

DATE 5/15/95

Embedment Effects (Cont'd)

$$\begin{aligned} f_{hx} &= 1 + \left(.33 + \frac{1.34}{1 + 55/50} \right) \left(\frac{12.3}{150} \right)^{.8} = \\ &= 1 + 1.3105 \times .1352 = 1.177 \end{aligned}$$

$$\text{Impact of Freq. Shift} \approx \sqrt{f_{hx}} = 1.085$$

Embedment results into shift of frequency towards higher frequencies by ~ 8%.

Negligible!

LANL

STRUCTURAL EVALUATION OF NMSF FACILITY AT LANL

As-Built Structure

DESIGNED BY B. Mosaddad DATE 2/10/95
CHECKED BY SV DATE 2/15/95

5.4 ACCIDENTAL TORSION EFFECTS

Accidental Torsional effects are accounted for by moving the computed center of gravity away from the center of rigidity to each floor for a distance equal to 5% of the overall building dimension in the corresponding direction.

Displacement of C.G. Coordinates

<u>FLOOR</u>	<u>ΔX</u>	<u>ΔY</u>
Basement	2.68'	7.44'
1st Floor	7.13	9.09
Roof	7.13	9.09

LANL

STRUCTURAL EVALUATION OF NMSF FACILITY AT LANL

As-Built Structure

DESIGNED BY B. Mosaddad

DATE 3/10/95

CHECKED BY J✓

DATE 5/15/95

5.5 FREQUENCY ANALYSIS RESULTS

Eigen Value Analysis Printout
Including Frequencies and Mass
Participation Factors are Printed on
next pages for the following
SD90 Models:

NMSF0 : Fixed Base

NMSF01 : Includes SSS Soil Springs

NMSF03 : Rigid Floor, No Torsion Effects.

NMSF04 : Rigid Floors, 5% Accidental
Mass Eccen. Included.

NMSF41 : (Same as NMSF04)
Mode shape Plots.

T I G E N V A L U E S A N D F R E Q U E N C I E S

MODE NUMBER	EIGENVALUE (RAD/SEC)**2	CIRCULAR FREQ (RAD/SEC)	FREQUENCY (CYCLES/SEC)	PERIOD (SEC)
1	0.770812E+04	0.877959E+02	13.973148	0.071566
2	0.973286E+04	0.986552E+02	15.701469	0.063688
3	0.119735E+05	0.109423E+03	17.415265	0.057421
4	0.124459E+05	0.111561E+03	17.755520	0.056321
5	0.148530E+05	0.121873E+03	19.396656	0.051555
6	0.263193E+05	0.162232E+03	25.820061	0.038730
7	0.383896E+05	0.195933E+03	31.183655	0.032068
8	0.436152E+05	0.208843E+03	33.238318	0.030086
9	0.517730E+05	0.227537E+03	36.213610	0.027614
10	0.822205E+05	0.286741E+03	45.636271	0.021912

A R T I C I P A T I N G M A S S - (percent)

MODE	X-DIR	Y-DIR	Z-DIR	X-SUM	Y-SUM	Z-SUM
1	73.284	0.019	0.007	73.284	0.019	0.007
2	0.009	1.117	0.000	73.293	1.136	0.007
3	0.341	0.032	0.000	73.634	1.168	0.007
4	0.053	0.060	0.014	73.687	1.227	0.021
5	0.017	70.506	0.004	73.705	71.733	0.026
6	5.053	0.115	0.004	78.757	71.848	0.029
7	2.052	8.846	0.125	80.810	80.694	0.154
8	0.335	1.207	2.329	81.145	81.901	2.483
9	11.363	1.997	0.090	92.508	83.898	2.573
10	0.017	0.071	63.546	92.525	83.969	66.119

I G E N V A L U E S A N D F R E Q U E N C I E S

MODE NUMBER	EIGENVALUE (RAD/SEC)**2	CIRCULAR FREQ (RAD/SEC)	FREQUENCY (CYCLES/SEC)	PERIOD (SEC)
1	0.509647E+04	0.713896E+02	11.362001	0.088013
2	0.539964E+04	0.734822E+02	11.695063	0.085506
3	0.880761E+04	0.938489E+02	14.936513	0.066950
4	0.106612E+05	0.103253E+03	16.433257	0.060852
5	0.119197E+05	0.109177E+03	17.376088	0.057550
6	0.128523E+05	0.113368E+03	18.043056	0.055423
7	0.212757E+05	0.145862E+03	23.214646	0.043076
8	0.221158E+05	0.148714E+03	23.668550	0.042250
9	0.309049E+05	0.175798E+03	27.979097	0.035741
10	0.332912E+05	0.182459E+03	29.039234	0.034436

A R T I C I P A T I N G M A S S - (percent)

ODE	X-DIR	Y-DIR	Z-DIR	X-SUM	Y-SUM	Z-SUM
1	92.282	0.229	0.223	92.282	0.229	0.223
2	0.272	87.620	0.052	92.554	87.849	0.275
3	0.339	0.085	98.333	92.893	87.934	98.608
4	0.000	0.083	0.095	92.894	88.017	98.704
5	0.115	0.225	0.079	93.009	88.243	98.783
6	0.018	8.435	0.118	93.026	96.678	98.901
7	3.257	0.009	0.128	96.283	96.687	99.029
8	0.028	2.085	0.016	96.311	98.772	99.045
9	0.597	0.000	0.818	96.908	98.772	99.864
10	2.393	0.019	0.025	99.301	98.791	99.889

EIGENVALUES AND FREQUENCIES

MODE NUMBER	EIGENVALUE (RAD/SEC)**2	CIRCULAR FREQ (RAD/SEC)	FREQUENCY (CYCLES/SEC)	PERIOD (SEC)
1	0.534738E+04	0.731257E+02	11.638325	0.085923
2	0.546127E+04	0.739004E+02	11.761616	0.085022
3	0.594000E+04	0.770714E+02	12.266295	0.081524
4	0.126489E+05	0.112467E+03	17.899731	0.055867
5	0.185804E+05	0.136310E+03	21.694400	0.046095
6	0.298748E+05	0.172843E+03	27.508843	0.036352
7	0.325896E+05	0.180526E+03	28.731589	0.034805
8	0.512355E+05	0.226353E+03	36.025150	0.027758
9	0.740126E+05	0.272053E+03	43.298508	0.023095
10	0.152804E+06	0.390902E+03	62.213989	0.016074

NMSF03

- Rigid floor diaphragm
- No Accidental Mass eccentricity included

Compare with NMSF01

A R T I C I P A T I N G M A S S - (percent)

MODE	X-DIR	Y-DIR	Z-DIR	X-SUM	Y-SUM	Z-SUM
1	89.940	2.131	1.858	89.940	2.131	1.858
2	1.546	89.975	2.437	91.486	92.106	4.295
3	2.597	2.000	95.017	94.083	94.106	99.312
4	0.021	4.622	0.192	94.103	98.728	99.504
5	3.793	0.005	0.315	97.896	98.733	99.819
6	1.852	0.000	0.019	99.748	98.734	99.838
7	0.034	0.003	0.000	99.781	98.737	99.838
8	0.003	1.234	0.000	99.785	99.971	99.838
9	0.215	0.005	0.000	99.999	99.976	99.839
10	0.000	0.000	0.154	99.999	99.976	99.992

EIGENVALUES AND FREQUENCIES

MODE NUMBER	EIGENVALUE (RAD/SEC)**2	CIRCULAR FREQ (RAD/SEC)	FREQUENCY (CYCLES/SEC)	PERIOD (SEC)
1	0.536718E+04	0.732610E+02	11.659858	0.085764
2	0.547712E+04	0.740076E+02	11.778674	0.084899
3	0.598411E+04	0.773570E+02	12.311752	0.081223
4	0.122998E+05	0.110904E+03	17.650970	0.056654
5	0.175968E+05	0.132653E+03	21.112371	0.047366
6	0.277197E+05	0.166492E+03	26.498063	0.037739
7	0.325468E+05	0.180407E+03	28.712696	0.034828
8	0.534203E+05	0.231128E+03	36.785228	0.027185
9	0.680837E+05	0.260929E+03	41.528068	0.024080
10	0.165478E+06	0.406790E+03	64.742695	0.015446

✓

NMSF04

additional

- Include $\pm 5\%$ Mass eccentricity

- Compare with NMSF03

A R T I C I P A T I N G M A S S - (percent)

ODE	X-DIR	Y-DIR	Z-DIR	X-SUM	Y-SUM	Z-SUM
1	93.489	0.440	0.112	93.489	0.440	0.112
2	0.471	92.333	0.885	93.959	92.773	0.997
3	0.070	1.059	98.660	94.030	93.833	99.656
4	0.013	4.912	0.205	94.043	98.745	99.861
5	3.767	0.016	0.000	97.809	98.761	99.862
6	1.299	0.000	0.000	99.108	98.761	99.862
7	0.561	0.073	0.001	99.669	98.835	99.864
8	0.010	1.150	0.001	99.679	99.985	99.865
9	0.318	0.000	0.001	99.997	99.985	99.865
10	0.000	0.000	0.125	99.997	99.985	99.990

<p>Z</p> <p>X</p>	<p>nmsf41</p> <p>MODE</p> <p>SHAPE</p> <p>MODE</p> <p>I</p>	<p>MINIMA</p> <p>X 0.2531E-01</p> <p>Y-0.9743E-02</p> <p>Z-0.9443E-02</p> <p>MAXIMA</p> <p>X 0.5160E-01</p> <p>Y-0.4724E-02</p> <p>Z 0.1088E-01</p>	<p>SAP90</p>
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nmsr4l

MODE

SHAPE

MODE

2

MINIMA

X 0.3302E-02

Y 0.2987E-01

Z-0.2069E-01

MAXIMA

X 0.9702E-02

Y 0.4962E-01

Z 0.1119E-01

SAP90

201.175 27.1

nmsf4l
 MODE
 SHAPE
 MODE 4

MINIMA
 X-0.1409E-02
 Y-0.3812E-02
 Z-0.7447E-01
 MAXIMA
 X 0.2553E-02
 Y 0.2751E-01
 Z 0.8038E-01

SAP90

Z
↑
X

nmsf41

MODE

SHAPE

MODE

5

MINIMA

X-0.1554E-01

Y-0.5590E-02

Z-0.6114E-01

MAXIMA

X 0.4417E-01

Y 0.4933E-02

Z 0.9067E-01

SAP90

nm5f4l

MODE

SHAPE

MODE

8

MINIMA

X-0.3019E-01

Y-0.6357E-01

Z-0.2313E-01

MAXIMA

X 0.3201E-01

Y 0.6431E-01

Z 0.2408E-01

SAP90

LANL
STRUCTURAL EVALUATION OF NMSF FACILITY AT LANL
As-Built Structure

DESIGNED BY B. Mosaddad DATE 3/10/95
CHECKED BY JL DATE 5/15/95

6.0 DEMAND VERSUS CAPACITY**6.1 WALL IN-PLANE SHEAR AND BENDING OF SHEAR**

LOS ALAMOS NMSF BUILDING EVALUATION
AS-BUILT

DESIGNED BY A. Sahe DATE 2.13.95
CHECKED BY BM DATE 3/14/95

WALL SEGMENT 19 (Line ①) Demand $V_u = 1477^k$ outside }
Length = 150 ft. , Width = 1'-4" , Vert. Reinf. #8@9 O.F.
#5@9 I.F. Inside }

Height $h = 15'-0$ (First floor to roof).

$$M_u = 1477 \times 15' = 22,155^kft \quad \text{conservative}$$

$$A_s = (0.79 + 0.31) \times \frac{12}{9} = 1.467 \text{ in}^2/\text{ft}$$

$$0.4L = 0.4 \times 150' = 60 \text{ ft} \quad \text{Total } A_s = 60 \times 1.467 = 88 \text{ in}^2$$

$$a = \frac{88 \times 60}{0.85 \times 4 \times 16} = 97.1 \text{ in.}$$

$$\phi M_n = 0.9 \times 88 \times 60 \times \left(0.8 \times 150 - \frac{97.1}{12 \times 2} \right) = 551,000^kft$$

Basement

$$M_u = 22155 + 822 \times 21 = 39,417^kft \quad \text{conservative}$$

Width = 1'-6" ; Vert. reinf. #10@9" E.F. ; $h = 21 \text{ ft.}$ Each

$$A_s = 1.693 \times 2 \times 60 = 203 \text{ in}^2$$

$$a = \frac{203 \times 60}{0.85 \times 4 \times 18} = 199 \text{ in.}$$

$$\phi M_n = 0.9 \times 203 \times 60 \times \left(0.8 \times 150 - \frac{199}{12 \times 2} \right) = 1,224,000^kft$$

$$\frac{\text{Demand}}{\text{Capacity}} = \frac{22,155}{551,000} = 0.04 \text{ for 1st floor.}$$

$$= \frac{39,417}{1,224,000} = 0.03 \text{ for Basement.}$$

Demand / capacity values are very low.

$\therefore$ In plane overturning calculation for all other long walls is not required.

Check overturning for short wall (Wall Segment 10)

NMSF @ LANL

AS-BUILT

DESIGNED BY A. Saha DATE 2.13.91

CHECKED BY BM DATE 3/10/91

Wall Segment 10 ;

Length ≈ 23 ft , Width = 1'-0" , Vert. Reinf. # 8 @ $7\frac{1}{2}$ "
+ # 7 @ 10"

$$A_s = 0.6 \times 1.2 + 0.79 \times \frac{12}{7.5} = 1.984 \text{ in}^2/\text{ft}.$$

$$0.4L = 0.4 \times 23 = 9.2 \text{ ft. Say } 9'-0"$$

$$\text{Total } A_s = 1.984 \times 9 = 17.856 \text{ in}^2.$$

$$a = \frac{17.856 \times 60}{0.85 \times 4 \times 12} = 26.26 \text{ in}.$$

$$\phi M_n = 0.9 \times 17.856 \times 60 \times \left(0.8 \times 23 - \frac{26.26}{2 \times 12} \right) = 16,687 \text{ k-ft}$$

$$\text{Demand } M_u \times \frac{V_u}{V_u} \times 189 \text{ k} \times 21 \text{ ft} = 3969 \text{ k-ft}$$

$$\frac{\text{Demand}}{\text{Capacity}} = \frac{3969}{16,687} = 0.24 < 1.0$$

By inspection , all other short walls are also O.K.

Job 41552

KAISER
ENGINEER

Calc. S-0001, Rev. 0

SHEET 186 OF 274

Evaluation of NMSE 2 LANE

BY: BM

DATE: 3-1-95

CHKD: J✓

DATE: 5/19/95

AS-BUILT

SUMMARY OF IN-PLANE SHEAR D/C RATIOS (AS-BUILT)

WALL SEGME	LENGTH L (FEET)	WIDTH Be(*) (FEET)	CAPACIT (Vc) (KIPS)	DEMAN (Vu) (KIPS)	(D/C) Vu/Vc
3	148.7	1.5	2763	822	0.30
6	148.7	1.45	2671	868	0.33
8	35	1	434	167	0.39
9	72.5	1.38	1239	1216	0.98
12	55	1.5	1022	788	0.77
4	128.7	1	1594	485	0.30
5	105.8	1	1310	432	0.33
1	22.9	1	284	84	0.30
10	19	1	235	189	0.80
11	23.9	1.21	358	264	0.74
19	148.7	1.33	2450	1477	0.60
34	53.5	1.33	881	692	0.79
27	72.5	1.12	1006	695	0.69
21	105.8	1.25	1638	1333	0.81
20	22.9	1.33	377	222	0.59
29	53.5	0.55	364	325	0.89
28	80	1	991	758	0.76
25	128.3	0.86	1367	996	0.73
35	78	1	966	736	0.76
38	80	1	991	745	0.75
32	23.9	1.21	358	253	0.71

$$v_c = .85 * 2 * \text{SQRT}(f'_c) = 108 \text{ PSI}$$

$$V_c = .8 * v_c * L * B_e$$

Be = Effective Wall Thickness

LOS ALAMOS NMSF BUILDG. EVALUATION
AS-BUILT STRUCTURE

DESIGNED BY BM

DATE 2/1/03

CHECKED BY JV

DATE 9/9/91

WALL IN-PLANE SHEAR

WALL : 3 (LINE 1 - Basement)

SHELL ELEMENT	JOINT	LC1 F _y	LC2 F _y
1101	1001	61	-32
	1011	57	-38
1102	1011	18	-11
	1021	5	-25
1103	1021	32	-36
	1031	19	-48
1104	1031	33	-33
	1041	19	-48
1105	1041	34	-33
	1051	19	-48
1106	1051	35	-33
	1061	18	-49
1107	1061	35	-33
	1071	17	-49
1108	1071	35	-33
	1081	17	-51
1109	1081	27	-19
	1091	5	-37
1110	1091	19	-73
	1101	3	-93
WALL BASE SHEAR	Σ	488	822

LOS ALAMOS NMSF BLDG. EVALUATION

AS-BUILT STRUCTURE

DESIGNED BY 12111

DATE 2/1/95

CHECKED BY JV

DATE 5/17/95

WALL 2D-PLANE SHEAR

WALL 2D 6

SHELL ELEMENT	JOINT	LC1 F	LC2 F
1301	1004	56	-45
	1044	46	-55
2	1014	19	-11
	1024	8	-26
3	1024	38	-25
	1034	27	-44
4	1034	38	-31
	1044	26	-44
5	1044	39	-31
	1054	26	44
6	1054	40	-31
	1064	25	-45
7	1064	38	-32
	1074	22	-47
8	1074	39	-33
	1084	25	-48
9	1084	27	-22
	1094	8	36
1310	1094	2	-96
	1104	-20	-114
WALL BASE SHEAR	Σ	569	868

LOS ALAMOS NMSF BUILDG. EVALUATION

AS-BUILT STRUCTURE

DESIGNED BY BNI DATE 2/1/10

CHECKED BY *JV* DATE *5/12*

WALL IN-PLANE SHEAR

WALL : 9

SHELL ELEMENT	JOINT	LC1 F_x	LC2 F_x
2201	1101	84	-104
	1102	65	-115
2202	1103	27	-122
	1103	45	-137
2203	1103	99	-200
	1104	75	-214
2204	1104	61	-143
	1105	51	-181
WALL BASE SHEAR	Σ	547	1216

LOS ALAMOS NMSF BUILDG. EVALUATION
AS-BUILT STRUCT

DESIGNED BY BIM DATE 2/1/95
CHECKED BY JV DATE 8/19/96

WALL IN-PLANE SHEAR

REF. SAP90 RUN:

WALL: 8

21'-10" EAST OF LINE (3) - BASEMENT

SHELL ELEMENT	JOINT	LC1 F_y	LC2 F_y
1451	1075	30	-16
	1085	20	-26
1452	1085	22	-11
	1095	9	-23
1453	1095	24	-42
	1105	14	-49
WALL BASE SHEAR	$V_u = \Sigma$	116	-167

LOS ALAMOS NMSF BLDG. EVALUATION
AS-BUILT STRUCTURE

DESIGNED BY E.H.

DATE 2/1/92

CHECKED BY TV

DATE 5/19/94

WALL IN-PLANE SHEAR

WALL : 12

SHELL ELEMENT	JOINT	LC1 F_x	LC2 F_x
2601	1001	43	-108
	1002	23	-121
2602	1002	53	-105
	1003	43	-114
2603	1003	80	-165
	1004	73	-175
WALL BASE SHEAR	Σ	315	788

SHELL ELEMENT	JOINT	LC1	F _y	LC2	F _y
1151	1002	40	-24	-31	-7
	12	37	-31	-7	17
	12	12	-7	17	22
2	22	5	17	22	22
	33	14	-32	-23	32
3	32	14	-32	-22	32
	42	14	-31	-22	42
4	42	14	-31	-22	42
	52	24	-32	-22	52
6	62	13	-32	-22	62
	72	24	-22	-22	72
7	72	11	-34	-38	72
	82	9	-38	-45	82
8	82	1	-45	-22	82
	92	-4	-29	-22	92
WALL BASE SHEAR					
	$V_u = \Sigma$	294	485		

WALL: 4
Line 1.5

WALL IN-PLANE SHEAR REF. SAP90 REV.:

<p>ICF KAISER ENGINEERS Cal. S-0001, Rev. 0</p>	<p>LOS ANGELES NM5F BUILDING EVALUATION</p>	<p>AS-BUILT STRUCTURE</p>	<p>CHECKED BY <u>SV</u> DATE <u>5/1/95</u></p>
<p>JOB NO. <u> </u></p>	<p>DESIGNED BY <u>BM</u> DATE <u>2/1/95</u></p>	<p>SHEET 192 OF 274</p>	

LOS ALAMOS NMSF BUILDG. EVALUATION
AS-BUILT STRUCTURE

DESIGNED BY BM DATE 2/1/95

CHECKED BY JV DATE 5/17/95

WALL IN-PLANE SHEAR

REF. SAR90 RUN:

WALL: 5 Line 2

SHELL ELEMENT	JOINT	LC1 F _y	LC2 F _y
1211	1013		-7
	23		-15
2	23		-22
	33		-31
3	33		-22
	43		-31
4	43		-22
	53		-31
5	53		-22
	63		-32
6	63		-22
	73		-34
7	73		-40
	83		-47
8	83		-24
	93		-30
WALL BASE SHEAR	$V_u = \Sigma$		432

LOS ALAMOS NMSF BUILDG. EVALUATION
AS-BUILT STRUCTURE

DESIGNED BY BM

DATE 2/1/95

CHECKED BY JV

DATE 3/9/95

WALL IN-PLANE SHEAR

REF. SAP90 RUN:

WALL: 1 LINE 2

SHELL ELEMENT	JOINT	LC1 F _y	LC2 F _y
1201	1003	38	-38
	1013	33	-46
WALL BASE SHEAR	$V_u = \Sigma$		84

LOS ALAMOS NMSF BUILDG. EVALUATION
AS-BUILT STRUCTURE

DESIGNED BY BM

DATE 2/1/95

CHECKED BY J L

DATES 5/19/96

WALL IN-PLANE SHEAR

REF. SAP90 RUN:

WALL: 10 line C-

SHELL ELEMENT	JOINT	LC1 F_x	LC2 F_x
2301	1074	42	-87
	1075	38	-102
WALL BASE SHEAR	$V_u = \Sigma$		189

LOS ALAMOS NMSF BUILDG. EVALUATION
AS-BUILT STRUCTURE

DESIGNED BY BM

DATE 2/1/95

CHECKED BY JV

DATE 5/19/95

WALL IN-PLANE SHEAR

REF. SAP90 RUN:

WALL: 11 LINE F

SHELL ELEMENT	JOINT	LC1 F _x	LC2 F _y
2501	1013	67	-130
	1014	60	-134
WALL BASE SHEAR	$V_u = \sum$		<u>-264</u>

LOS ALAMOS NMSF BUILDG EVALUATION
AS-BUILT STRUCTURE

DESIGNED BY P.M.

DATE 2/1/95

CHECKED BY JLV

DATE 2/1/98

WALL IN-PLANE SHEAR

REF. SAP90 RUN:

WALL: 19 line 1

SHELL ELEMENT	JOINT	LC1 Fy	LC2 Fy
3101	4001		-114
	4011		-116
2	11		-29
	21		-38
3	21		-73
	31		-79
4	31		-70
	41		-77
5	41		-70
	51		-77
6	51		-62
	61		-72
7	61		-63
	71		-70
8	71		-64
	81		-73
9	81		-39
	91		-51
3110	91		-114
	101		-122
WALL BASE SHEAR	$V_u = \sum$		1477

LOS ALAMOS NMSF BUILDING EVALUATION
AS-BUILT STRUCTURE

DESIGNED BY BM

DATE 2/1/95

CHECKED BY JL

DATE 3/10/95

WALL IN-PLANE SHEAR

REF. SAP90 RUN:

WALL: 34 Line C

SHELL ELEMENT	JOINT	LC1 F _x	LC2 F _x
4701	4002		-100
	3		-110
2	3		-92
	4		-94
3	4		-143
	5		-153
WALL BASE SHEAR	$V_u = \sum$		692

LOS ALAMOS NMSF BUILDG. EVALUATION
AS-BUILT STRUCTURE

DESIGNED BY B.M. DATE 3/1/95

CHECKED BY 5 ✓ DATE 8/12/91

WALL IN-PLANE SHEAR

REF. SAPAO RUN:

WALL: 27

Line B

SHELL ELEMENT	JOINT	LC1 F_x	LC2 F_x
4201	4101		54
	2		59
2	2		78
	3		85
3	3		115
	4		120
4	4		88
	5		96
WALL BASE SHEAR	$V_u = \sum$		695

LOS ALAMOS NMSF BUILDING EVALUATION
AS-BUILT STRUCTURE

DESIGNED BY BSM

DATE 2/1/95

CHECKED BY JV

DATE 5/18/95

WALL IN-PLANE SHEAR

REF. SAP90 RUN:

WALL: 21

F_x value
~~Correct~~ Use F_y values.

SHELL ELEMENT	JOINT	LC1 F_y	LC2 F_y
3301	4014	#28	-25
	24	#21	-20
2	24	#69	-1-72
	34	62	-1-78
3	34	68	-2-73
	44	#61	-4-79
4	44	#68	-1-72
	54	62	-1-79
5	54	69	-1-72
	64	2 61	-4-79
6	64	3 67	-6-71
	74	4 60	-5-80
7	74	3 70	-1-70
	84	65	-2-78
8	84	50	-38
	94	7 37	-52
9	94	25 40	20-142
	104	31 33	20-145
WALL BASE SHEAR	$V_u = \Sigma$	991 Small	87 -1333

LOS ALAMOS NMSF BUILDG. EVALUATION
AS-BUILT STRUCTUREDESIGNED BY BIM DATE 2/1/95CHECKED BY JV DATE 5/10/95

WALL IN-PLANE SHEAR

REF. SAP90 RUN:

WALL: 21

SHELL ELEMENT	JOINT	LC1 F _y	LC2 F _y
3301	4014	28	-25
	24	21	-28
2	24	69	-72
	34	62	-78
3	34	68	-73
	44	61	-79
4	44	68	-72
	54	62	-79
5	54	69	-72
	64	61	-79
6	64	67	-71
	74	60	-80
7	74	70	-70
	84	65	-78
8	84	50	-38
	94	37	-52
9	94	40	-142
	104	33	-145
WALL BASE SHEAR	$V_u = \Sigma$	991	-1333

LOS ALAMOS NMSF BUILDG. EVALUATION

AS-BUILT STRUCTURE

DESIGNED BY BM

DATE 3/1/95

CHECKED BY JV

DATE 3/19/95

WALL IN-PLANE SHEAR

REF. SAP90 RUN:

WALL: 20

Line 2

SHELL ELEMENT	JOINT	LC1 FY	LC2 FY
3201	4003	95	-108
	13	90	-114
WALL BASE SHEAR	$V_u = \sum$		222

LOS ALAMOS NMSF BUILDING EVALUATION
AS-BUILT STRUCTURE

DESIGNED BY BM

DATE 3/1/95

CHECKED BY JV

DATE 5/12/95

WALL IN-PLANE SHEAR

REF. SAP90 RUN:

WALL: 29

Line C

SHELL ELEMENT	JOINT	LC1 F _x	LC2 F _x
4401	4061		-56
	2		-66
2	2		-41
	3		-42
3	3		-60
	4		-60
WALL BASE SHEAR	$V_u = \sum$		325

LOS ALAMOS NMSF BUILDC. EVALUATION
AS-BUILT STRUCTURE

DESIGNED BY BM

DATE 2/1/95

CHECKED BY JL

DATE 5/10/95

WALL IN-PLANE SHEAR

REF. SAP90 RUN:

WALL: 28

Line B

SHELL ELEMENT	JOINT	LC1 F _x	LC2 F _x
4221	4105		-100
	6		-108
2	6		-69
	7		-75
3	7		-104
	8		-113
4	8		-50
	9		-56
5	9		-36
	4110		-47
WALL BASE SHEAR	$V_u = \sum$		758

LOS ALAMOS NMSF BUILDING EVALUATION
AS-BUILT STRUCTURE

DESIGNED BY BM DATE 2/1/95

CHECKED BY JV DATE 5/1/95

WALL IN-PLANE SHEAR

REF. SARAO RUN:

WALL: 25

Line 7

SHELL ELEMENT	JOINT	LC1 F _y	LC2 F _y
3701	4008		85
	18		87
2	18		23
	28		26
3	28		58
	38		62
4	38		57
	48		60
5	48		56
	58		61
6	58		57
	68		61
7	68		56
	78		61
8	78		57
	88		62
9	88		31
	98		36
WALL BASE SHEAR	$V_u = \Sigma$		<u>996</u>

LOS ALAMOS NMSF BUILDG. EVALUATION
AS-BUILT STRUCTURE

DESIGNED BY Bm

DATE 2/1/92

CHECKED BY T ✓

DATE 5/9/95

WALL IN-PLANE SHEAR

REF. SAPAO RUN:

WALL: 35

LINE G

SHELL ELEMENT	JOINT	LC1 F_x	LC2 F_x
4711	4004		89
	5		93
2	5		99
	6		103
3	6		98
	7		102
4	7		73
	8		79
WALL BASE SHEAR	$V_u = \sum$		736

LOS ALAMOS NMSF BUILDG. EVALUATION
AS-BUILT STRUCTURE

DESIGNED BY BM

DATE 2/1/95

CHECKED BY JV

DATE 5/10/95

WALL IN-PLANE SHEAR

REF. SAP90 RUN:

WALL: 38

LINE A

SHELL ELEMENT	JOINT	LC1 F _x	LC2 F _x
4101	4125		90
	6		96
2	6		69
	7		78
3	7		106
	8		113
4	8		50
	9		57
5	9		38
	4130		48
WALL BASE SHEAR	$V_u = \Sigma$		745

LOS ALAMOS NMSF BUILDG. EVALUATION
AS-BUILT STRUCTURE

DESIGNED BY BMM DATE 3/1/9

CHECKED BY JV DATE 5/14/95

WALL IN-PLANE SHEAR

REF. SAP90 RUN:

WALL: 32

LIN F

SHELL ELEMENT	JOINT	LC1 Fx	LC2 Fx
4751	4013		120
	4014		132
WALL BASE SHEAR	$V_u = \Sigma$		<u>253</u>

LOS ALAMOS NMSF BUILDING EVALUATION

AS-BUILT STRUCTURE

DESIGNED BY A. Laha DATE 2.10.95

CHECKED BY JV DATE 5/10/95

WALL IN-PLANE SHEAR

DL = DEAD LOAD

LL = LIVE LOAD

H = SOIL PRESS.

LC1 = LOAD CASE 1 1.4 DL + 1.7 L.L.

LC2 = LOAD CASE 2 1.4 DL + 1.7 L.L. + 1.7 H

AS-BUILT ; WALL : 3 (LINE 1 - BASEMENT)

SHELL ELEMENT	JOINT	LC1 F _y IN KIPS	LC2 F _y IN KIPS	REMARKS
1101	1001	18	26	
	1011	3	16	
1102	1011	10	7	
	1021	-9	-15	
1103	1021	11	0	
	1031	-9	-21	
1104	1031	13	3	
	1041	-10	-20	
1105	1041	14	4	
	1051	-10	-21	
1106	1051	15	5	
	1061	-11	-22	
1107	1061	16	5	
	1071	-13	-24	
1108	1071	16	5	
	1081	-14	-25	
1109	1081	16	8	
	1091	-16	-23	
1110	1091	4	-37	
	1101	-29	-71	
WALL BASE SHEAR	Σ	15	-200	

REF. COMPUTER RUN NMSF42.FEF

LOS ALAMOS NMSF BUILDING EVALUATION

AS-BUILT STRUCTURE

DESIGNED BY A. Saha DATE 2.10.95CHECKED BY IV DATE 5/12/95WALL IN-PLANE SHEAR

DL = DEAD LOAD

LL = LIVE LOAD

H = SOIL PRESS.

LC1 = LOAD CASE 1 1.4 DL. + 1.7 L.L.

LC2 = LOAD CASE 2 1.4 DL. + 1.7 LL + 1.7H

AS-BUILT ; WALL: 6 (LINE 3 - BASEMENT)

SHELL ELEMENT	JOINT	LC1 F _y IN KIPS	LC2 F _y IN KIPS	REMARKS
1301	1004	16	12	
	1014	2	-4	
1302	1014	9	8	
	1024	-8	-11	
1303	1024	10	7	
	1034	-8	-12	
1304	1034	12	8	
	1044	-8	-12	
1305	1044	13	9	
	1054	-9	-13	
1306	1054	14	10	
	1064	-10	-14	
1307	1064	14	8	
	1074	-12	-17	
1308	1074	15	7	
	1084	-12	-17	
1309	1084	15	7	
	1094	-14	-21	
1310	1094	4	-66	
	1104	-26	-99	
WALL BASE SHEAR	Σ	17	-210	

REF. COMPUTER RUN NMSF42.FEF

REF. COMPUTER RUN NMSF42.FEF

[illegible]

WALL IN-PLANE SHEAR

WALL IN-PLANE SHEAR

DL = DEAD LOAD	
LL = LIVE LOAD	
H = SOIL PRESS.	
LC2 = LOAD CASE 2	1.4 DL + 1.7 LL + 1.7H
LC1 = LOAD CASE 1	1.4 DL + 1.7 LL
AS-BUILT ; WALL : 12 (LINE 9 - BASEMENT)	

SHEET 212 OF 274

DESIGNED BY

CHECKED BY

DATE 5/10/95

LOS ALAMOS NM SF BUILDING EVALUATION

AS-BUILT STRUCTURE

**ILF KAISER
ENGINEERS**

Calc 50001, Row. 0

LOS ALAMOS NMSF BUILDING EVALUATION

AS-BUILT STRUCTURE

DESIGNED BY A. Salas DATE 2.10.95.

CHECKED BY Jv DATE 5/1/96

WALL IN-PLANE SHEAR

DL = DEAD LOAD

LL = LIVE LOAD

H = SOIL PRESS.

LC1 = LOAD CASE 1 1.4 DL + 1.7 L.L.

LC2 = LOAD CASE 2 1.4 DL + 1.7 L.L. + 1.7 H

AS-BUILT; WALL: 4 (LINE 15' EAST OF LINE 1 - BASEMENT)

SHELL ELEMENT	JOINT	LC1 F _y IN KIPS	LC2 F _y IN KIPS	REMARKS
1151	1002	11	15	
	1012	1	6	
1152	1012	7	5	
	1022	-6	-9	
1153	1022	7	1	
	1032	-6	-12	
1154	1032	8	3	
	1042	-6	-12	
1155	1042	9	3	
	1052	-7	-13	
1156	1052	10	4	
	1062	-8	-13	
1157	1062	10	3	
	1072	-9	-16	
1158	1072	7	-19	
	1082	-11	-32	
1159	1082	3	-13	
	1092	-14	-25	
WALL BASE SHEAR	Σ	6	-124	

REF. COMPUTER RUN NMSF42.FEF

LOS ALAMOS NMSF BUILDING EVALUATION

AS-BUILT STRUCTURE

DESIGNED BY A. LahaDATE 2.10.95CHECKED BY JLDATE 9/0/95WALL IN-PLANE SHEAR

DL = DEAD LOAD

LL = LIVE LOAD

H = SOIL PRESS.

LC1 = LOAD CASE 1 1.4 DL. + 1.7 L.L.

LC2 = LOAD CASE 2 1.4 DL. + 1.7 LL + 1.7H

AS-BUILT ; WALL: 5 (LINE 2 - BASEMENT)

SHELL ELEMENT	JOINT	LC1 F _y IN KIPS	LC2 F _y IN KIPS	REMARKS
1211	1013	7	5	
	1023	-6	-7	
1212	1023	7	3	
	1033	-6	-10	
1213	1033	8	4	
	1043	-6	-11	
1214	1043	9	5	
	1053	-7	-11	
1215	1053	9	5	
	1063	-7	-12	
1216	1063	10	4	
	1073	-8	-15	
1217	1073	7	-22	
	1083	-11	-34	
1218	1083	3	-15	
	1093	-13	-26	
WALL BASE SHEAR	Σ	-4	-137	

REF. COMPUTER RUN NMSF 42.FEF

LOS ALAMOS NMSF BUILDING EVALUATION

AS-BUILT STRUCTURE

DESIGNED BY A. Saha

DATE 2.10.95

CHECKED BY J

DATE

WALL IN-PLANE SHEAR

DL = DEAD LOAD

LL = LIVE LOAD

H = SOIL PRESS.

LC1 = LOAD CASE 1 1.4 DL + 1.7 LL

LC2 = LOAD CASE 2 1.4 DL + 1.7 LL + 1.7 H

AS-BUILT; WALL : 1 (LINE 2 - BASEMENT)

SHELL ELEMENT	JOINT	LC1 F _y IN KIPS	LC2 F _y IN KIPS	REMARKS
1201	1003	12	4	
	1013	1	-7	
WALL BASE SHEAR	Σ	13	-3	

REF. COMPUTER RUN NMSF 42.FEF

LOS ALAMOS NMSF BUILDING EVALUATION

AS-BUILT STRUCTURE

DESIGNED BY A. Sahu DATE 2.10.95.

CHECKED BY DATE

WALL IN-PLANE SHEAR

LC1 = LOAD CASE 1 1.4 DL. + 1.7 L.L.

LC2 = LOAD CASE 2 1.4 DL. + 1.7 L.L. + 1.7 H

AS-BUILT; WALL: 10 (LINE C - BASEMENT)

DL = DEAD LOAD

LL = LIVE LOAD

H = SOIL PRESS.

SHELL ELEMENT	JOINT	LC1 F _x IN KIPS	LC2 F _x IN KIPS	REMARKS
2301	1074	4	-25	
	1075	-10	-40	
WALL BASE SHEAR	Σ	-6	-65	

REF. COMPUTER RUN NMSF 42. FEF

WALL IN-PLANE SHEAR

DL = DEAD LOAD

LL = LIVE LOAD

H = SOIL PRESS.

LC1 = LOAD CASE 1 1.4 DL. + 1.7 L.L.

LC2 = LOAD CASE 2 1.4 DL. + 1.7 L.L. + 1.7 H

AS-BUILT; WALL: 11 (LINE F - BASEMENT)

SHELL ELEMENT	JOINT	LC1 F _x IN KIPS	LC2 F _x IN KIPS	REMARKS
2501	1013	3	-33	
	1014	-8	-43	
WALL BASE SHEAR	Σ	-5	-76	

REF. COMPUTER RUN NMSF 42, FEF

WALL IN-PLANE SHEAR

DL = DEAD LOAD

LL = LIVE LOAD

H = SOIL PRESS.

LC1 = LOAD CASE 1 1.4 DL. + 1.7 L.L.

LC2 = LOAD CASE 2 1.4 DL. + 1.7 L.L. + 1.7 H

AS-BUILT; WALL: B (21'-10" EAST OF LINE ③ - BASEMENT)

SHELL ELEMENT	JOINT	LC1 F _y IN KIPS	LC2 F _y IN KIPS	REMARKS
1451	1075	16	14	
	1085	1	-2	
1452	1085	11	10	
	1095	-9	-10	
1453	1095	1	-12	
	1105	-17	-26	
WALL BASE SHEAR	Σ	3	-26	

REF. COMPUTER RUN NMSF42.FEF

LOS ALAMOS NMSF BUILDING EVALUATION

AS-BUILT STRUCT

DESIGNED BY A. Salha DATE 2.10.95CHECKED BY JV DATE 2-19WALL IN-PLANE SHEAR

DL = DEAD LOAD

LL = LIVE LOAD

H = SOIL PRESS.

LC1 = LOAD CASE 1 1.4 DL + 1.7 LL

LC2 = LOAD CASE 2 1.4 DL + 1.7 LL + 1.7 H

AS-BUILT; WALL: 19 (LINE 1 - 1ST FLOOR)

SHELL ELEMENT	JOINT	LC1 F _y IN KIPS	LC2 F _y IN KIPS	REMARKS
3101	4001	9	23	
	4011	1	15	
3102	4011	5	3	
	4021	-5	-9	
3103	4021	5	-1	
	4031	-5	-10	
3104	4031	5	1	
	4041	-5	-9	
3105	4041	5	1	
	4051	-5	-8	
3106	4051	6	11	
	4061	-5	-2	
3107	4061	6	10	
	4071	-6	0	
3108	4071	6	4	
	4081	-5	-8	
3109	4081	7	7	
	4091	-6	-8	
3110	4091	-1	-29	
	4101	-13	-39	
WALL BASE SHEAR	Σ	-1	-48	

REF. COMPUTER RUN NMSF 42.FEF

LOS ALAMOS NMSF BUILDING EVALUATION

AS-BUILT STRUCT

DESIGNED BY A. Saha DATE 2.10.95.

CHECKED BY J ✓ DATE 5-19-9

WALL IN-PLANE SHEAR

DL = DEAD LOAD

LL = LIVE LOAD

H = SOIL PRESS.

LC1 = LOAD CASE 1 1.4 DL. + 1.7 L.L.

LC2 = LOAD CASE 2 1.4 DL. + 1.7 L.L. + 1.7 H

AS-BUILT; WALL: 34 (LINE - 1ST FLOOR)

SHELL ELEMENT	JOINT	LC1 F _x IN KIPS	LC2 F _x IN KIPS	REMARKS
4701	4002	7	-34	
	4003	0	-47	
4702	4003	4	-19	
	4004	-4	-25	
4703	4004	3	-29	
	4005	-5	-39	
WALL BASE SHEAR	Σ	5	-193	

REF. COMPUTER RUN NMSF 42.FEF

WALL IN-PLANE SHEAR

LC1 = LOAD CASE 1 1.4 DL. + 1.7 L.L.

LC2 = LOAD CASE 2 1.4 DL. + 1.7 L.L. + 1.7 H

AS-BUILT; WALL: 27 (LINE - 1ST FLOOR)

DL = DEAD LOAD

LL = LIVE LOAD

H = SOIL PRESS.

SHELL ELEMENT	JOINT	LC1 F _X IN KIPS	LC2 F _X IN KIPS	REMARKS
4201	4101	10	16	
	4102	0	8	
4202	4102	6	-7	
	4103	-5	-18	
4203	4103	5	-1	
	4104	-5	-11	
4204	4104	5	1	
	4105	-6	-9	
WALL BASE SHEAR	Σ	10	-21	

REF. COMPUTER RUN NMSF 42.FEF

LOS ALAMOS NMSF BUILDING EVALUATION

AS-BUILT STRUCT

DESIGNED BY A. Saha

DATE 2-10-95

CHECKED BY JV

DATE

WALL IN-PLANE SHEAR

DL = DEAD LOAD

LL = LIVE LOAD

H = SOIL PRESS.

LC1 = LOAD CASE 1 1.4 DL + 1.7 L.L.

LC2 = LOAD CASE 2 1.4 DL + 1.7 L.L. + 1.7 H

AS-BUILT; WALL: 21 (LINE - 1ST FLOOR)

SHELL ELEMENT	JOINT	LC1 F _y IN KIPS	LC2 F _y IN KIPS	REMARKS
3301	4014	5	2	
	4024	-1	-4	
3302	4024	6	-1	
	4034	-2	-9	
3303	4034	5	-2	
	4044	-4	-10	
3304	4044	5	-1	
	4054	-4	-10	
3305	4054	5	-1	
	4064	-5	-10	
3306	4064	5	-1	
	4074	-5	-12	
3307	4074	6	1	
	4084	-5	-8	
3308	4084	6	8	
	4094	-5	-9	
3309	4094	0	-61	
	4104	-11	-69	
WALL BASE SHEAR	Σ	1	197	

REF. COMPUTER RUN NMSF42.FEF

WALL IN-PLANE SHEAR

DL = DEAD LOAD

LL = LIVE LOAD

H = SOIL PRESS.

LC1 = LOAD CASE 1 1.4 DL + 1.7 L.L.

LC2 = LOAD CASE 2 1.4 DL + 1.7 L.L. + 1.7 H

AS-BUILT; WALL 20 (LINE 2 - 1ST FLOOR)

SHELL ELEMENT	JOINT	LC1 F _y IN KIPS	LC2 F _y IN KIPS	REMARKS
3201	4003	4	- 6	
	4013	-4	-14	
WALL BASE SHEAR	Σ	0	-20	

REF. COMPUTER RUN NMSF42.FEF

LOS ALAMOS NMSF BUILDING EVALUATION

AS-BUILT STRUCT

DESIGNED BY A. Saha DATE 2.10.95.

CHECKED BY SV DATE 5/20

WALL IN-PLANE SHEAR

DL = DEAD LOAD

LL = LIVE LOAD

H = SOIL PRESS.

LC1 = LOAD CASE 1 1.4 DL. + 1.7 L.L.

LC2 = LOAD CASE 2 1.4 DL. + 1.7 L.L. + 1.7 H

AS-BUILT; WALL: 28 (LINE B - 1ST FLOOR)

SHELL ELEMENT	JOINT	LC1 F _y IN KIPS	LC2 F _y IN KIPS	REMARKS
4221	4105	4	-11	
	4106	-5	-22	
4222	4106	4	-6	
	4107	-5	-15	
4223	4107	4	-12	
	4108	-5	-21	
4224	4108	3	-4	
	4109	-5	-13	
4225	4109	0	-5	
	4110	-7	-14	
WALL BASE SHEAR	Σ	-12	-123	

REF. COMPUTER RUN NMSF42.FEF

LOS ALAMOS NMSF BUILDING EVALUATION
AS-BUILT STRUCT

DESIGNED BY A. Saha DATE 2.10.95
CHECKED BY TL DATE 5.10.95

WALL IN-PLANE SHEAR

LC1 = LOAD CASE 1 1.4 DL. + 1.7 L.L.

LC2 = LOAD CASE 2 1.4 DL. + 1.7 L.L. + 1.7 H

DL = DEAD LOAD

LL = LIVE LOAD

H = SOIL PRESS.

AS-BUILT; WALL: 25 (LINE 7 - 1ST FLOOR)

SHELL ELEMENT	JOINT	LC1 F _y IN KIPS	LC2 F _y IN KIPS	REMARKS
3701	400B	5	-5	
	401B	0	-10	
3702	401B	2	0	
	402B	-3	-6	
3703	402B	3	-5	
	403B	-2	-10	
3704	403B	3	-3	
	404B	-3	-9	
3705	404B	3	-4	
	405B	-3	-10	
3706	405B	3	-4	
	406B	-3	-10	
3707	406B	3	-3	
	407B	-3	-10	
3708	407B	3	-4	
	408B	-4	-11	
3709	408B	0	-4	
	409B	-5	-9	
WALL BASE SHEAR	Σ	-1	-117	

REF. COMPUTER RUN NMSF 42.FEF

LOS ALAMOS NMSF BUILDING EVALUATION

AS-BUILT STRUCT

DESIGNED BY A. Caba DATE 2.13.97

CHECKED BY JK DATE 7-26-64

WALL IN-PLANE SHEAR

DL = DEAD LOAD

LL = LIVE LOAD

H = SOIL PRESS.

LC1 = LOAD CASE 1 1.4 DL. + 1.7 L.L.

LC2 = LOAD CASE 2 1.4 DL + 1.7 LL + 1.7H

AS-BUILT ; WALL: 3S (LINE G - 1ST FLOOR)

SHELL ELEMENT	JOINT	LC1 F _x IN KIPS	LC2 F _x IN KIPS	REMARKS
4711	4004	2	-18	
	4005	-3	-24	
4712	4005	3	-20	
	4006	-3	-26	
4713	4006	3	-20	
	4007	-3	-25	
4714	4007	0	-17	
	4008	-5	-22	
WALL BASE SHEAR	Σ	-6	-172	

REF. COMPUTER RUN NMSF42.FEF

LOS ALAMOS NMSF BUILDING EVALUATION

AS-BUILT STRUCT

DESIGNED BY A. Saha DATE 2.13.95

CHECKED BY IV DATE 12/1/71

WALL IN-PLANE SHEAR

DL = DEAD LOAD

LL = LIVE LOAD

H = SOIL PRESS.

LC1 = LOAD CASE 1 1.4 DL. + 1.7 L.L.

LC2 = LOAD CASE 2 1.4 DL. + 1.7 L.L. + 1.7 H

AS-BUILT; WALL: 38 (LINE A - 1ST FLOOR)

SHELL ELEMENT	JOINT	LC1 F _x IN KIPS	LC2 F _x IN KIPS	REMARKS
4101	4125	10	-2	
	4126	1	-12	
4102	4126	5	-5	
	4127	-6	-16	
4103	4127	4	-10	
	4128	-5	-19	
4104	4128	4	-3	
	4129	-6	-13	
4105	4129	0	-5	
	4130	-8	-13	
WALL BASE SHEAR	Σ	-9	-98	

REF. COMPUTER RUN NMSF42.FEF

WALL IN-PLANE SHEAR

DL = DEAD LOAD

LL = LIVE LOAD

H = SOIL PRESS.

LC1 = LOAD CASE 1 1.4 DL. + 1.7 L.L.

LC2 = LOAD CASE 2 1.4 DL + 1.7 LL + 1.7H

AS-BUILT; WALL:32 (LINE F - 1ST FLOOR)

SHELL ELEMENT	JOINT	LC1 F _x IN KIPS	LC2 F _x IN KIPS	REMARKS
4751	4013	3	-23	
	4014	-9	-32	
WALL BASE SHEAR	Σ	-1	-55	

REF. COMPUTER RUN NMSF42.FEF

NMSF22
UNDEFORMED
SHAPE

OPTIONS
ELEMENT IDS
WIRE FRAME

SAP90

Sheet 2 of 2

NMSF22
UNDEFORMED
SHAPE

OPTIONS
ELEMENT IDS
WIRE FRAME

SAP90

Sht. 231 of 270

NMSF41
UNDEFORMED
SHAPE

OPTIONS
JOINT IDS
ALL JOINTS
WIRE FRAME

SAP90

8/1.23294

NMSF41
UNDEFORMED
SHAPE

OPTIONS
HIDDEN LINES

SAP90

AS-BUILT
WALL ID,
BETWEEN
1ST FLOOR
and
ROOF

NMSF41
UNDEFORMED
SHAPE

OPTIONS
PROPERTY IDS
WIRE FRAME

SAP90

**ICF KAISER
ENGINEERS**

Calc. No. S-0001 Rev. 0

JOB NO. 41552
SHEET 240 OF 271

LANL

STRUCTURAL EVALUATION OF NMSF FACILITY AT LANL

As-Built Structure

DESIGNED BY B. Mosaddad DATE 3/10/95

CHECKED BY *IL* DATE 3/10/95

6.2 WALL OUT-of-PLANE SHEAR AND BENDING

LOS ALAMOS NMSF BUILDING

DESIGNED BY B.M. DATE 2/10/9.

EVALUATION OF AS-BUILT STRUCTURE

CHECKED BY ✓ DATE 2/10/9.WALL OUT-OF-PLANE BENDING

UNITS = KIPS, FEET

WALL SEGMENT	LC1 = DL + LL + H ± E		LC2 = 1.4DL + 1.7LL + H ± E		Demand (*)	Capacity	D/C
	(+)M	(-)M	(+)M	(-)M			
M = 3	38.6	-21.5	55.0	-30.1			
M = 19	27.3	-14.1	32.3	-16.9			
M = 12, 34	5.1	-3.1	5.2	-3.0			
M = 9	9.1	-11.4	13.6	-16.0			
M = 27	13.5	-26.3	16.4	-31.5			
Others	-4.5	-6.8	5.2	-6.9			
REFERENCE SAP90 MODEL	← NMSF41 →		← NMSF42 →				

(*) $D = \text{Max}(LC1, LC2)$

LANL

STRUCT EVAL. OF NMSF FACILITY

AS-BUILT

DESIGNED BY B. Moxadder DATE 1/15

CHECKED BY J. DATE 1/15

Computation of OUT-OF-plane Response

SAP90 RUN

Description

NMSF41

 $DL + LL + H + E$ $DL + LL + H - E$

NMSF42

 $1.4DL + 1.7LL$ $1.4DL + 1.7LL + 1.7H$

LOAD combinations required

1) NON-SEISMIC

 $1.4DL + 1.7LL + 1.4Ta$ $1.4DL + 1.7LL + 1.7H + 1.4Ta$

2) SEISMIC

 $DL + LL + H + E/F_h + T_o$ $DL + LL + H - E/F_h + T_o$ Assume $F_h = 1.0$ Conservatively T_a = Accidental Thermal stress T_o = Operational Condition Thermal stress

MIN IS -0.856E+01 <JOINT 3081> MAX IS 0.613E+01 <JOINT 1011>

nmsf41

SHELL

OUTPUT M11

LOAD 1

$\times 10^{-1}$

64 32 0 -32 -64 -96

SAP90

nmsf41
SHELL
OUTPUT M22
LOAD 1

$\times 10^{-1}$

390
260
130
0
-130
-260

MIN IS -0.203E+02 <JOINT 3011> MAX IS 0.386E+02 <JOINT 4011>

SAP90

file
 M=3

nmsf41
 SHELL
 OUTPUT M22
 LOAD 2

$\times 10^{-1}$

SAP90

MIN IS (-0.215E+02 JOINT 3011) MAX IS 0.367E+02 JOINT 4011

Line 1

11=3

nmsf41

SHELL
OUTPUT M11

LOAD 1

$\times 10^{-1}$

68
34
0
-34
-68
-102

MIN IS -0.856E+01 <JOINT 3081> MAX IS 0.655E+01 <JOINT 4011>

SAP90

Line 1

M1=3

nmsf41
SHELL
OUTPUT M11
LOAD 2

X 10⁻¹

SAP90

MIN IS -0.890E+01 <JOINT 3081> MAX IS 0.623E+01 <JOINT 4011>

line 1
 M=19
 1st Floor

nmsf41
 SHELL
 OUTPUT M11
 LOAD 1

$\times 10^{-1}$

SAP90

MIN IS -0.382E+01 <JOINT 5011> MAX IS 0.465E+01 <JOINT 4011>

Line 1

11-19

nmsf41
SHELL
OUTPUT M11
LOAD 2

$\times 10^{-2}$

450
270
90
-90
-270
-450

MIN IS -0.414E+01 <JOINT 5011> MAX IS 0.434E+01 <JOINT 4011>

SAP90

Line 1

11=19

nmsf41
SHELL
OUTPUT M22
LOAD 1

$\times 10^{-1}$

315
225
135
45
-45
-135

MIN IS -0.128E+02 <JOINT 5011> MAX IS 0.273E+02 <JOINT 4011>

SAP90

five1
p1=19

nmsf41
 SHELL
 OUTPUT M22
 LOAD 2

SAP90

MIN IS -0.141E+02 <JOINT 5011> MAX IS 0.255E+02 <JOINT 4011>

Line 6
 $M = 12, 34$

MIN IS -0.254E+01 <JOINT 3001> MAX IS 0.872E+00 <JOINT 7002>

nmsf41
 SHELL
 OUTPUT M11
 LOAD 1

$\times 10^{-2}$

SAP90

nmsf41
SHELL
OUTPUT M11
LOAD 2

Line 6
M=12,344

MIN IS -0.275E+01 <JOINT 3001> MAX IS 0.627E+00 <JOINT 7002>

SAP90

nmsf41
 SHELL
 OUTPUT M22
 LOAD 1

SAP90

Line 6
 p1=11,34

MIN IS -0.166E+01 <JOINT 5002> MAX IS 0.513E+01 <JOINT 7002>

nmsf41
SHELL
OUTPUT M22
LOAD 2

Line 6
11=11,54

MIN IS -0.308E+01 <JOINT 5002> MAX IS 0.369E+01 <JOINT 7002>

SAP90

line B
AI=9

MIN IS -0.166E+01 <JOINT 1103> MAX IS 0.203E+01 <JOINT 2102>

nmsf41
SHELL
OUTPUT M11
LOAD 1

$\times 10^{-2}$

SAP90

nmsf41
 SHELL
 OUTPUT M22
 LOAD 2

/1112 B
 M=9

MIN IS -0.114E+02 <JOINT 1103> MAX IS 0.871E+01 <JOINT 2103>

SAP90

27 254 22

nm5f41
SHELL
OUTPUT M22
LOAD 1

SAP90

MIN IS -0.251E+02 <JOINT 4103> MAX IS 0.135E+02 <JOINT 5103>

Line 13
1st floor
M=27

Line B
 1st Floor
 M1=27

nmsf41
 SHELL
 OUTPUT M11
 LOAD 1

SAP90

MIN IS -0.427E+01 <JOINT 4103> MAX IS 0.320E+01 <JOINT 5102>

L100 B
 157 F10
 P1-27

MIN IS -0.447E+01 <JOINT 4103> MAX IS 0.305E+01 <JOINT 5102>

nmsf41
 SHELL
 OUTPUT M11
 LOAD 2

SAP90

Line B
1st Floor
M=17

MIN IS -0.263E+02 <JOINT 4103> MAX IS 0.128E+02 <JOINT 5103>

nmsr41
SHELL
OUTPUT M22
LOAD 2

X 10⁻¹

SAP90

Sh 2534 11

nmsf4l

SHELL

OUTPUT M22

LOAD 2

$\times 10^{-1}$

48
24
0
-24
-48
-72

SAP90

*All other
walls*

MIN IS $-0.679E+01$ <JOINT 4094> MAX IS $0.431E+01$ <JOINT 7062>

NMSF42

SHELL
OUTPUT M22
LOAD 2

SAP90

M=14
 wall on line 1
 1st floor → Roof

MIN IS -0.169E+02 <JOINT 5011> MAX IS 0.323E+02 <JOINT 4011>

Y Z X

NMSF42
 SHELL
 OUTPUT M22
 LOAD 2

X 10⁻¹

330
 220
 110
 0
 -110
 -220

SAP90

84+ 204 4 22

NMSF42
SHELL
OUTPUT M22
LOAD 2

SAP90

	NMSF42		$\times 10^{-1}$	52
	SHELL			26
	OUTPUT M22			0
	LOAD 2			-26
				-52
				-78
				SAP90

others

MIN IS -0.685E+01 <JOINT 7094> MAX IS 0.518E+01 <JOINT 7062>

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SHEET 273 OF 274

LANL

STRUCTURAL EVALUATION OF NMSF FACILITY AT LANL

DESIGNED BY B. Mosaddad DATE 7/1/05

As-Built Structure

CHECKED BY [Signature] DATE 7/1/05

6.3 MISCELANEOUS EVALUATIONS

NMSF BUILDING - LANL

DESIGNED BY A. Seiler DATE 2.16.91

AS-BUILT STRUCTURE

CHECKED BY BM DATE 3/9/92

Connection of Prestressed double Tee to wall —
Reference Det. (12) Dwg. S-9 and Det. (25) Dwg. S-10
Width of web of Tee's not available - measured from
Det. (25) to be = 7 inches.

Connection (welding) is at Line (3) only.

Connection of double Tee flanges at Lines (B) & (E)
per dwg. S-3 and Det 54, dwg. S-11 (Shear keys @ 5'-0.0.0.)

Capacity of Weld @ Line (3)

Capacity parallel to Line (3) = $21 \times 0.707 \times \frac{1}{4} \times 7'' = 26^k$ ↓ assumed

" perpendicular to Line (3) = $21 \times 0.707 \times \frac{1}{4} \times (5-1'') \times 2 = 29.7^k$
(Gap assumed) ↑

∴ Capacity parallel to Line (3) per ft. = $\frac{2 \times 26}{8} = 6.5^k/\text{ft.}$

" ⊥ to Line (3) per ft. = $\frac{2 \times 29.7}{8} = 7.42^k/\text{ft.}$

Capacity of Conn. @ Lines (B) & (E)

Flat bar $\frac{3}{8} \times 1\frac{1}{2} \times 2''$ in bearing = $0.375 \times (1.5 - 0.5) \times 27^{\text{ksi}} = 10.1^k$ Gap assumed
 $\frac{3}{16}$ fillet = $21 \times 0.707 \times \frac{3}{16} \times 2'' \times 2 = 11.1^k$ Governs

∴ Conn. Capacity per ft. = $\frac{10.1}{5'} = 2^k/\text{ft.}$

NOTE: Wall is free at Line (7)

Assuming 3" flange and 7' x 25" web

$$\text{D.L.} = 40 \text{ Psf.} + \left(\frac{3'' \times 8' \times 150^{\text{pcf}}}{12} + \frac{2 \times 7' \times 25' \times 150^{\text{pcf}}}{12 \times 12} \right) / 8' = 123^{\text{Psf.}}$$

↳ From Note B.S Dwg. S-3

Earthquake load / ft. = $0.3 \times \frac{123 \times 73'}{1000} = 2.7^k/\text{ft. width}$
 $< 6.5^k/\text{ft.} \therefore \text{O.K.}$

Load @ (B) & (E) due to Torsion = $\frac{2.7 \times 92' \times 73'}{2 \times 92' \times 73'} = 1.35^k/\text{ft.}$
 $< 2^k/\text{ft.} \therefore \text{O.K.}$