**FMP (FACILITY MODIFICATION PACKAGE) FORM**

### Design Package Identification

1. **Mod Title:**
   Pallets, 48 x 48 and 56 x 56

   **Key Words:**
   N/A

2. **Project No./Work Package No.:**
   N/A

3. **Review Designators:**
   N/A

   Additional Reviewers:

4. **Area**
   200G

5. **Building**
   N/A

6. **System No.**
   N/A

7. **FMP Author**
   K D HEIN

8. **Release:**
   Release CACN 118798

   MAR 13 2007
   DATE:
   STA: 5
   HANFORD
   RELEASE
   ID:
   72

   Modification Work Complete and Field Verified
   Not Approved/Archive

9. **USQ Required?**
   No.

10. **Environmental-Activity Screening Form Completed?**
    NO

    If Yes, is the Environmental-Activity Form Attached? NO

11. **Distribution - Name**
    MSIN

    Distribution - Name
    MSIN

    N/A

12. **Change Description (description and reason for requested change):**
    H-2-832930 PROVIDED FOR INITIAL RELEASE OF DRAWING SET.

### Approvals

13. **FMP Author**
    K D HEIN

    Print/Signature/Date
    03/21/07

14. **Design Authority**
    R STEEN

    Print/Signature/Date
    03/22/07

15. **Engineering Management**
    P HANADA

    Print/Signature/Date
    03/27/07

### Document Index

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16. **Related FMPs/Changes:**
   N/A

17. **Lead Engineering Discipline:**
   N/A

18. **Affected Engineering Disciplines:**
   N/A

### Modification Bases

19. **Engineering Request or Proposal:**
    CACN

20. **Change Status of Engineering Documents to be Modified:**
    N/A

<table>
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<tr>
<th>Document Number</th>
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Submit List to Document Control for Project Status? No.
FMP (FACILITY MODIFICATION PACKAGE) FORM (continued)

21. Potentially Affected Documents Not Changed By This FMP:

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<th>Document Type</th>
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22. Conceptual Evaluations:
N/A

23. Functions, Requirements, and Design Criteria:

Functions:
USED FOR STORAGE AND TRANSPORT OF DRUMS

Requirements:
MUST HAVE LOAD CAPACITY OF 12,000 LBS. MUST MEET CERTAIN SECTIONS OF ASME MH1 (2005) - SEE DWG NOTES ON SHT 1

Design Criteria:
SEE DWG NOTES ON SHT 1

24. Post-Installation Acceptance Test Criteria:

25. Design Verification:

Verification by: X Peer Review □ Formal Design Review □ Alternate Calculations □ Qualification Testing

Design Verification Record Form (A-6003-845) required per HNF-PRO-8336? □ YES X NO

Additional Design Verification Documentation Prepared? □ YES X NO

Design Verification Checklist Questions

a. Are the assumptions, functions, requirements, and design criteria appropriately selected? X YES □ NO
b. Does the design meet the stated assumptions, functions, requirements, and design criteria? X YES □ NO
c. Were the design inputs correctly incorporated into the design? X YES □ NO
d. Is the design output reasonable compared to the design inputs? X YES □ NO
e. Have suitable materials, parts, processes, and inspections and testing criteria been specified? X YES □ NO
f. Have manufacture, maintenance, and operability been adequately addressed in the design? X YES □ NO
g. Are all affected active design documents identified and appropriately changed? X YES □ NO

A review of the design has been performed. The selected functions, requirements, and design criteria meet the stated engineering request. The verification completed by the method(s) noted that this FMP is accurate, and the design defined by this FMP and related documents meets the stated functions, requirements, and design criteria.

Design Verifier: Michael L. Herbst
Print/Signature/Date 2/11/07
HNF-FMP-07-32540-RO

These calculations demonstrate the adequacy of the pallet currently ordered and used for SWOC. Throughout the
calculations, it is assumed that the wood used is Western White Pine. Western White Pine has the least desirable
mechanical properties of wood allowed by ASME MH1, Pallets, Slip Sheets, and Other Bases for Unit Loads, (2005).
This assumption builds conservatism, while bounding other wood selections allowed by MH1. Some other data was

Credit is taken for Administrative controls in place for limiting a single pallet to 4000 lbs, and that they can be stacked
a maximum of 3 high.

The fasteners used are 3 mm (D) x 2.75 in (L), helically threaded and hardened.

1) **Force required for shearing fasteners.**

   Assume the fastener material is low carbon steel (1025), with an ultimate tensile strength (UTS) of 70 ksi.
   Further assume that Shear is .75 of UTS. A pure shearing load for pallet fasteners is **highly** unlikely.

   \[
   \text{Shear} = \frac{\pi \times D^2 \times .75 \times UTS}{4} = \frac{3.14159(1.118)^2 \times .75(70 \text{ ksi})}{4} = 575 \text{ lbs.}
   \]

   Minimum 3 fasteners are used per connection point, so Shear = 3X, or 1725 lbs.

2) **Wood Failure between Fasteners – Shear Loading**

   Wood Tear (WT) = (p – D) x 1 x S(t), where S(t) = Tensile Strength of Pine Perp to Grain, p = distance
   between fasteners (3 ea) on a 2 x 6 pallet.

   \[
   S(t) = 330 \text{ psi} \quad \text{So, } \quad WT = (1.375 -.118) \times 1.5 \times 330 = 622 \text{ lbs.}
   \]

3) **Force Withdrawal Resistance (FWI). See MH1 for values and definitions**

   \[
   \text{FWI} = 221 \times (WD) \times \left[ 1 + 27.15 \times (TD – WD) \times (H / TL) \right] = 221 \times (.118) \times \left[ 1 + 27.15 \times (.142 -.118) \times (9 / 1.75) \right] = 113
   \]

4) **Fastener Withdrawal Resistance Value (FWRF). Single fastener. See MH1 for values and definitions**

   \[
   \text{FWRF} = 222.2 \times \text{FWI} \times (\text{OS}^{.25}) \times P / (MC - 3) = 222.2 \times 113 \times (40 / 62.4)^{.25} \times 1.5 / (20 – 3) = 818 \text{ lbf}
   \]

5) **Fastener Head Pull-Through Resistance Value (HPRF). Single fastener. See MH1 for values and definitions**

   \[
   \text{HPRF} = 1.25 \times 10^6 \times \frac{T}{.75} \times (\text{GD}^{2.25} \times (\text{HD}^2 \times \text{WD}^3) / (\text{MC} - 3)) = 1.25 \times 10^6 \times .75 \times (40 / 62.4)^{2.25} \times (28^2 -.118) / (20 – 3) = 1307 \text{ lbf}
   \]
6) **Crushing Pallet Material Perp to the Grain** – *Machinery's Handbook* offers a range of 190 psi to 470 psi.

   Pallet Stringers are 48 in long 2 x 4 members. Actual dimensions of a finished 2 x 4 is 1 1/2 x 3 1/2.

   Single stringer contact area with a single deck board = 5 1/2 in x 1 1/2 in = 8.25 in²

   The 48 x 48 pallet has 4 total stringers and 4 bottom deck boards, making 16 areas of contact, so
   Total Area = 16 x 8.25 = 132 in²

   The Admin Control for pallets is 4000 lbs max per pallet, and a maximum of 3 stacks high, for a total of
   12,000 lbs.

   The maximum pressure exerted on the bottom pallet is 12,000 lbs / 132 in² = 91 psi << 190 psi. This offers a
   safety factor in excess of 2 even if the lowest crushing strength value is used.

Calculations 1 and 2 demonstrate an intuitively obvious dynamic, that in a shear load condition, the material between
fasteners would fail before the fastener would. Again, shear loading for pallets is highly unlikely, and is an off-normal
condition for pallet use.

Calculations 3, 4 and, 5 offer performance criteria for the pallet in use at SWOC. They provide the forces needed for
fastener pullout and fastener head pull-through for a single fastener. The drawing requires a minimum 3 fasteners at
each attachment location between stringer and deck board, and this attribute increases each of the criteria by the total
number of fasteners.

Calculation 6 demonstrates that, under maximum static loading, the pallet material will not crush due to overloading.
PARTS/MATERIAL LIST

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<th>PART</th>
<th>SPECIFICATION</th>
<th>MATERIAL/REFERENCE</th>
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<tr>
<td>-100</td>
<td>PALLET, 48 X 48</td>
<td>1.5</td>
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<tr>
<td>-200</td>
<td>PALLET, 56 X 56</td>
<td>2.2</td>
</tr>
<tr>
<td>A8 A8</td>
<td>061</td>
<td>STRAIGHT BOARD, 2 X 4</td>
</tr>
<tr>
<td>A8 A8</td>
<td>062</td>
<td>DECK BOARD, 2 X 6 (TOP AND BOTTOM)</td>
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GENERAL NOTES:
1. DIMENSIONS ARE IN INCHES. TOLERANCES AND FASTENING METHODS ARE PER ANSI B14.1 (CHISEL POINT) PART I-8.
2. EACH ATTACHMENT POINT OF A DECK BOARD OR A STRAIGHT BOARD SHALL HAVE A MINIMUM OF 3 FASTENERS. OTHER FASTENERS SHALL BE ANY CONVENTIONALLY AVAILABLE TYPE DESIGNED IN STANDARD INDUSTRY PRACTICES, AND IN COMPLIANCE WITH ANSI B14.1 (CHISEL POINT) PART II. VERSATILE THREADED NAILS ARE PREFERRED.
3. IN THE 48 X 48 PALLETS, THE TOP DECK BOARD SHAL HAVE A TOP DECK BOARD SPACED AT 1/2 IN. THE BOTTOM DECK BOARD SHALL BE SECURELY FASTENED ALONG THE LENGTH. THE STRAIGHT BOARD SHALL BE SECURELY FASTENED ALONG THE WIDTH.
4. EACH 56 X 56 PALLET SHALL HAVE A TOP DECK BOARD SPACED AT 2 IN. THE BOTTOM DECK BOARD SHALL BE SECURELY FASTENED ALONG THE LENGTH. THE STRAIGHT BOARD SHALL BE SECURELY FASTENED ALONG THE WIDTH.
5. MINIMUM LOAD CAPACITY FOR ITEMS 1 AND 2 IS 12,000 LBS. ITEMS 3 AND 4 TO BE COMPLIANT WITH THE 48 X 48 AND 56 X 56 PALLETS. WOOD STICKETS MAY BE ANY CONVENTIONALLY AVAILABLE PRODUCT THAT MEETS OR EXCEEDS THE LOAD CAPACITY FOR A FINISHED PALLETS, AND IS COMPLIANCE WITH ANSI B14.1 (CHISEL POINT) PART I-8.

SCALE NOTE: 1"

PALLET, 48 X 48

U.S. DEPARTMENT OF ENERGY

PALLET, 48 X 48 AND 56 X 56