# COLUMBIANA HI TECH LLC

Date: May 30, 2018

Attn: Document Control Desk
Director, Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Subject: Application for revision of Certificate of Compliance No. 9291 for the Model No. Liqui-Rad (LR) Transportation Unit Package, Docket No. 71-9291

References:

(1) NRC Certificate of Compliance for the Model No. Liqui-Rad (LR) Transportation Unit Package, USA/9291/B(U)F-96, Rev. 9
(2) Packaging Safety Analysis Report for the Liqui-Rad (LR) Transportation Unit Package, Revision 8

In accordance with 10 CFR 71.31, Columbiana Hi Tech, LLC (CHT) herewith submits an application to revise the Certificate of Compliance (CoC) for the Liqui-Rad (LR) Transportation Unit packaging. A supplement to the current CoC, Revision 9 [1], is submitted to revise the requirements for tightening the outer lid fasteners in the Operating Procedures in Chapter 7 of the application [2].

Changes to Revision 8 of the SAR are summarized in Enclosure 1, and the change pages for Revision 9 are included as Enclosure 2. "Security-Related Information" is removed and provided as an attachment to the SAR as Enclosure 3. Drawings showing detailed design information are removed from the SAR with a notation that the information was withheld on the basis that it is "Security-Related Information."

CHT has a quality assurance program, approved by the Commission, which satisfies the provisions of subpart H (Quality Assurance) of Part 71. Further, CHT complies with the terms and conditions of the applicable requirements of subparts A (General Provisions), G (Operating Controls and Procedures), and H (Quality Assurance) of Part 71.

Columbiana Hi Tech requests that the NRC issue Revision No. 10 of the Liqui-Rad (LR) Transportation Unit Package CoC referencing this application as a supplement.

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Should the NRC staff require additional information to support review of this application, please do not hesitate to contact Mr. Peter Vescovi at 336-852-5679.

Sincerely,

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Enclosure(s)
1) Summary of page changes for Revision 9 of Liqui-Rad (LR) Transportation Unit Package SAR
2) Change pages for Revision 9 of Liqui-Rad (LR) Transportation Unit Package SAR
3) SAR Attachment 1 – Security-Related Information

**ENCLOSURE 1**

The following list summarizes the changes to the Safety Analysis Report for Revision 9 for Certificate of Compliance No. 9291 for the Model No. Liqui-Rad (LR) Transportation Unit Package, Docket No. 71-9291.

| Affected Section or Pages | Change Description | Reason | Justification |
|---|---|---|---|
| Front matter<br>Title page | Update Title Page, | Revision | Editorial |
| Chapter 1<br>Page 1-1 thru 1-4 | Revised the description of the outer lid and gasket. | Clarify the function of the outer lid to provide access and protection for the containment boundary closures. | Outer lid is not a containment boundary closure. |
| Page 1-7 | Removed drawing LR-SAR | Security-related information | Withhold from public SAR and provided as separate attachment per RIS 2005-31. |
| Drawing LR-SAR | Revised Note 4. | Clarify the torque requirement for primary lid, secondary lid, and outer lid. | See Note 1. |
| | Revised Note 11. | Allow primer and paint that is equivalent to those specified. | Allows flexibility for fabrication and maintenance. |
| Section 7.1.2 Loading the Contents and Securing the Package for Shipment<br>Page 7-2 | Change torque requirement for outer lid stud bolts. | Eliminate damage to outer lid flange and flat gasket | See Note 1. |
| | Leak test criteria revised. | More clearly state the intent of ANSI 14.5 to demonstrate no leakage using a test with a sensitivity of 10-3 ref cm3/sec. | ANSI N14.5 prior to shipment leak test criteria |
| Section 7.4 Use of MVE Feature<br>Page 7-3 | Change torque requirement for MVE lid bolts. | Eliminate damage to MVE lid flange and flat gasket | See Note 1. |

| | | | |
|---|---|---|---|

**Note 1 - Justification for changing torque requirement for outer lid stud bolts and MVE lid bolts**

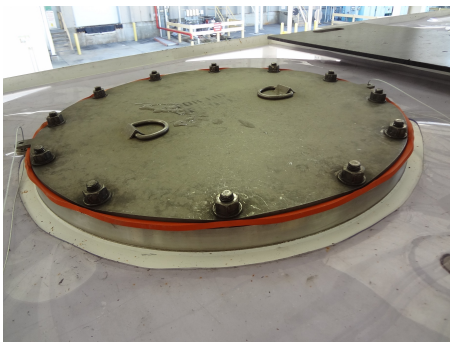
The LR packaging has three lids that use bolting fasteners—a primary lid, a secondary lid, and outer lid. The primary lid and secondary lid are containment boundary components. The secondary lid is removed for routine operations, but the primary lid remains in place unless removed to for maintenance activities. Both the primary lid and secondary lid provide seals for closure of the containment boundary. Note 11 on the engineering drawing for package approval, LIQUI-RAD TRANSPORT UNIT, Sheet 4 of 4, General Notes, states that "all closure bolts/studs shall be torqued prior to shipment to 75 ft. lbs. +10 -0." The outer lid provides thermal and impact protection, and provides no closure seal for the containment boundary. Therefore, the fasteners used to secure the outer lid to the packaging are not considered closure bolts/studs as specified in the General Notes.

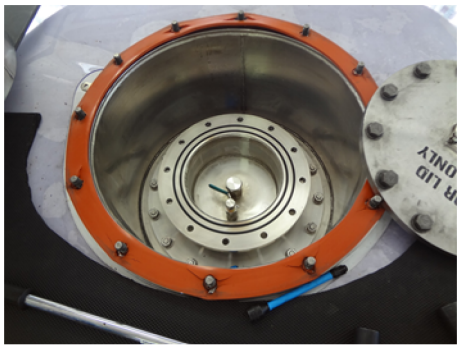
The operating procedures provide in Chapter 7 of the LIQUI-RAD Safety Analysis Report, specify torque values of 75 [+10 -0] ft. lbs. for the primary lid, secondary lid, and out lid fasteners. The primary lid is a 5/8 inch thick flange that is bolted to the containment vessel and secondary lid is ¾ inch thick plate that bolts to a ¾ inch thick flange on the primary lid. Both the primary and secondary lids are thick metal lids that are designed to withstand design pressures and compress o-rings to provide containment boundary closure seals. The intent of torqueing the closure bolts/studs is to provide a preload force that ensures the seals maintain leak tightness during routine, normal, and accident transport conditions. The outer lid is a ¼ thick steel plate with material for thermal and impact protection on the inside surface. There is also an optional manual vent enclosure (MVE) that houses a valve for venting any pressure build up between the outer lid and space outside the containment vessel. A flat rubber gasket provides an environmental seal between the outer lid and space that provides access to the containment vessel secondary and primary lids. The intent of the closure bolts on the outer lid is only to retain the outer lid that provides protection of the confinement boundary from condition incident to transport, including normal and accident conditions. The outer lid seal prevents ingress of water and dust incident to routine transport conditions.

There is no calculation done in the SAR to determine the minimum torque for a clamping force appropriate for tensile stress due to differential thermal expansions or impacts. Leak tests were performed after thermal and impact load tests to demonstrate that the containment boundary seals for the primary and secondary met the leak tight criteria. The clamping force required for the containment seals is not necessary to retain the outer lid and maintain an environmental seal.

Torqueing the outer lid fasteners to 75 ft.-lbs., as specified in the Chapter 7 – Operating Procedures, results in damage to the flat rubber gasket and deformation of the metal flange on the outer lid as shown in photographs below. The outer lid fasteners only need be tightened enough to compress the flat rubber gasket to provide environmental seal and prevent the fasteners from loosening from vibration during routine transport conditions. Tests have been performed to demonstrate that a torque of 30 [+10 -0] ft.-lbs. applied to the outer lid stud nuts

results is sufficient to compress the environmental seal and ensure the fasteners will not loosen when subject to conditions incident to routine transport.





A change to the Chapter 7- Operating Procedures is proposed that will prevent damage to the outer lid flange and gasket while providing sufficient clamping force to meet the design criteria. The outer lid placed over the bolting studs installed in a flange on the outer packaging shell, and secured using a washer and hex nut. The out lid fasteners are tightened using a recommended sequence and checking the final tightening ensure uniform compression of the gasket. The recommendations for tightening are also proposed for the secondary lid closure installation.

Note 11 on the engineering drawing for package approval, LIQUI-RAD TRANSPORT UNIT, Sheet 4 of 4 (LR-SAR Revision 10), General Notes, is revised to specify a torque value of 75 ft. lbs. for the primary lid and secondary lid that are part of the containment boundary. The outer lid nuts torque is specified as 30 ft. lbs. to ensure securement for shipping and prevent damage to the outer lid flange.

**ENCLOSURE 2**

Change Pages for Packaging Safety Analysis Report for the Liqui-Rad (LR) Transportation Unit Package, Revision 9

Title page

| | |
|---|---|
| Pages 1-1 thru 1-4 | Chapter 1- General Description |
| Page 1-7 | Appendix 1.3.1 Drawing Number LR-SAR, Sheets 1,2,3 &t for the Liqui-Rad Transport Unit |
| Page 7-2 | Section 7.1.2 Loading the Contents and Securing the Package for Shipment |
| Page 7-3 and 7-3a | Section 7.4 Use of MVE Feature |

# Safety Analysis Report (SAR)

## for the

# LIQUI-RAD TRANSPORT UNIT

(Revision 9, May 2018)

Submitted by:

Columbiana Hi Tech
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**SAFETY ANALYSIS REPORT FOR PACKAGING**

**LIQUI-RAD**
**TRANSPORT UNIT**
**(Revision 9, May 2018)**

Submitted by:
Columbiana Hi Tech, LLC
Kernersville, North Carolina 27284

# 1 GENERAL INFORMATION

This Safety Analysis Report for Packaging (SARP) for the Liqui-Rad (LR) Transport Unit is submitted in support of Columbiana Hi Tech's request for licensing of the subject package and issuance of a Type B Fissile Material Certificate of Compliance. The LR has been designed and evaluated in accordance with the requirements of the United States Code of Federal Regulations (Title 10 and 49) and IAEA Safety Standards (Series No. ST-1, 1996 edition). The application is explicitly limited to the transportation of Uranyl Nitrate (UN) solution as described in the chemical and radioactive characteristics set forth in Section 1.2.3.

## *1.1 Introduction*

The LR represents an innovative approach to the shipment of UN solution. The LR utilizes integral thermal and impact limiting systems to protect the containment vessel and prevent inadvertent discharge of the lading under Normal and Hypothetical Accident Conditions. The primary structural components of the LR packaging consist of a stainless steel containment vessel, a carbon steel outer vessel and a carbon steel framing system. Although the containment vessel is not stamped as such, it is built in accordance with the ASME Pressure Vessel Code (Section VIII, Division 1). Double O-ring seals located on the containment vessel's primary and secondary lids provide a complete and testable containment boundary. A flat gasket at the outer lid provides a seal against water and dust. As an additional feature, an optional valve is provided to check the pressure in the annulus space, and to vent the annulus space if required prior to revmoval of the outer lid. Two (2) tamper-proof seals are located on the outer lid. A strong, lightweight, closed-cell foam insulation surrounds the top and bottom head area of the containment vessel and ceramic fiber blanket and board insulation are used in the sidewalls and outer lid to limit thermal influences and impact forces. The maximum cargo capacity is limited to 230 gallons (870 liters), maintaining a minimum ullage of 33 gallons.

## *1.2 Package Description*

### 1.2.1 Packaging

#### 1.2.1.1 Overall Construction

As shown in the drawings provided in Appendix 1.3.1 (LR-SAR, sheets 1, 2, 3 and 4), the LR is a cylindrical package set in a rectangular angle frame having a foot print of 56" x 56" and a height of 73". The weights and volumes of the LR and contents are provided in Table 1-1. Table 1-2 provides a list of the materials of construction.

The outer vessel is constructed of welded 10 gauge carbon steel. The containment vessel is constructed of ¼" thick 304 or 316 stainless steel with ¼" thick flanged and dished heads. The containment vessel, although not stamped as such, is built in accordance with the ASME Pressure Vessel Code (Section VIII, Division 1) and is rated for an internal pressure of 50 psig and an external pressure of 30 psig. Lightweight, closed-cell foam insulation (CHT-6/8FOAM), and ceramic fiber insulation (ESP-CFI-2) (see Appendences 1.3.3 and 1.3.4 for specifications) are sandwiched between the containment vessel and outer shell to provide thermal insulation and limit impact effects. These insulation materials are inflammable and non-reactive with the steel components of the vessels.

The package is designed to be leak tight (maximum allowable leak rate of $10^{-7}$ ref-$cm^3$/sec) at the primary closure. The containment vessel's primary closure is at the primary lid. The primary closure is sealed using a double O-ring and is secured by sixteen 5/8" stainless steel studs. The primary lid includes a fill port consisting of a valve and stainless steel threaded (plugged) quick-disconnect fittings. The secondary lid provides a sealed enclosure around the valving and fittings on the primary lid. The secondary lid is sealed using a double O-ring and is secured by twelve 5/8" stainless steel bolts and nuts.

The outer lid consists of a steel-lined ceramic fiber plug and is secured with twelve 5/8" stainless steel studs. An optional manual valve enclosure (MVE) lid is secured with four 5/8" stainless steel bolts and nuts. These outer lid and MVE lid are not a part of the containment boundary, and thus need not be leak tight. A flat gasket provides a seal to prevent water and dust from conditions incident to routine transport from entering the annulus space between the outer protective packaging and containment vessel. The MVE valve is used to check the pressure in the annulus space and to vent the annulus space if required.

Four one-inch diameter plastic plugs, designed to melt away between 300° and 400° F and vent any gases that may be generated by the insulation during a fire event, are positioned at mid-height at 90° intervals along the circumference of the package. Additional plugs are located on the base and top of the unit. The plugs are protected by the framework of the package and do not penetrate the containment vessel.

All valves and fittings are provided within sealed enclosures to contain any leakage due to valve failure. The valves are protected from impact and temperature influences by the outer vessel and the insulation contained between the inner and outer vessels.

#### 1.2.1.2 Lifting and Tie down Devices

The LR may be lifted either by means of four shackles attached to the top angle frame or by forklift tines placed under the unit's reinforced bottom. The LR may be bolted to a conveyance and further secured by strapping over the top of the LR. After loading of the package, shackles shall be secured to the top angle with nylon tie to prevent shackle from being used as tie down. Package shall be stenciled "SHACKLE NOT FOR TIE DOWN". The packaging and cargo weights and volumes are provided in Table 1-1.

#### 1.2.1.3 Shielding

Shielding is not required for the contents of the LR Transport Unit. For further discussion of shielding requirements, see Section 5.

#### 1.2.1.4 Pressure Relief Systems

The LR uses only one type of pressure relief device: a plastic plug, designed to melt away between 300° and 400° F during a fire event to release any gases generated by the insulation due to the high temperature. This device vents the annulus between the containment vessel and outer shell only; it does not penetrate the containment boundary. Pressure relief of the containment vessel is unnecessary, since the contents do not present a pressure buildup during Normal or Hypothetical Accident Conditions. See Sections 2, 3, 4, and 7 for information with respect to internal pressure.

#### 1.2.1.5 Closures

The containment vessel is secured by bolting the 5/8" thick primary lid to the vessel with sixteen 5/8" diameter studs and nuts. The primary lid is sealed with a double O-ring. The secondary lid is sealed using twelve 5/8" diameter bolts and nuts or, as a design option, the secondary lid flange is threaded and the secondary lid is secured to it using twelve (12) 5/8" diameter bolts and a double O-ring. A valve, enclosed in the sealed annulus space between the primary lid and secondary lid, is used in conjunction with a threaded (plugged) quick disconnect fitting for filling and discharge functions. All seals are silicone rubber or Viton and are rated for continuous service up to 400°F.

#### 1.2.1.6 Containment

The containment boundary is defined by the containment vessel, primary lid (excluding the portion inside the secondary wall) and seal, and secondary lid and seal. The containment vessel has ¼" thick stainless steel walls and ¼" thick ASME flanged and dished heads and is designed to provide leak tight conditions. Post fabrication the containment boundary is demonstrated to be leak-tight (per ANSI N14.5-1997's definition, leakage rate less than 1E-07 ref-cc/sec). Pre-shipment and periodic maintenance testing of the containment boundary assures that the containment boundary maintains a working leakage rate less than the maximum allowable rates specified by 10CFR71.51 as specified in Section 4. Leak test are performed as specified in Sections 7 and 8.

### 1.2.2 Operational Features

The LR combines a highly secure and reliable pressure vessel with integral thermal and impact limiting systems to prevent breach of containment under Normal and Hypothetical Accident Conditions. The primary operational features of the LR include:

i.) A pressure vessel built in accordance with the ASME Code

ii.) An outer vessel, framing, and insulation to provide protection and stability for the containment system

iii.) A total of thirty-two (32) 5/8" diameter studs/bolts and nuts to provide positive closure of the primary lid and secondary lid,

iv.) Silicone Rubber or Viton double O-ring seals at the primary lid and secondary lid rated for continuous service up to 400° F to provide leak tight seals, and test ports for leak testing the seals,

v.) The fill valve and quick disconnect fitting are provided within the containment boundary to preclude leakage due to valve failure,

vi.) A bolted secondary lid that provides access to the fill valve.

vii.) A bolted outer lid that provides protection for the containment vessel and access to the secondary lid.

viii.) An optional valve on the outer lid for venting the annulus between the outer lid and containment vessel primary lid and secondary lid.

### 1.2.3 Contents of Packaging

The LR is used for the safe transport of low enriched UN solutions that meet the specifications presented in Table 1-3. Additionally, the UN solution temperature must be maintained below 210°F. The uranium concentration must be less than or equal to 125 gU/liter with an enrichment less than or equal to 5.0wt% U-235. Non-fissile chemical impurities do not adversely impact the criticality safety of the packaging; therefore, they may be present in any quantity up to the chemical impurity specification. Fissile isotopes are limited to the quantities specified in Table 1-3. Any number of packages may be transported together in any arrangement in either a vertical or horizontal orientation, therefore, the Criticality Safety Index (CSI) is 0. The maximum UN solution cargo per package is 1imited to 230 gallons (870 liters), maintaining a minimum ullage of 33 gallons.

## *1.3 Appendices*

1.3.1 Drawing Number LR-SAR, Sheets 1, 2, 3, & 4 for the Liqui-Rad Transport Unit

1.3.2 Epoxy Primer Specifications

1.3.3 CHT-6/8FOAM, Closed-Cell Foam Insulation Specification

1.3.4 ESP-CFI-2, Ceramic Fiber Insulation Specification

# Appendix 1.3.1

Drawing Number LR-SAR, Sheets 1, 2, 3, & 4 for the Liqui-Rad Transport Unit

# Drawing LR-SAR, Rev.10
# Sheets 1 through 4

# Security-Related Information
# Withheld Under 10 CFR 2.390
# per NRC RIS 2005-31

recommended and does not require testing per 8.2(g) except during the maintenance activities described in Section 8.

### 7.1.2 Loading the Contents and Securing the Package for Shipment

a. Filling of the containment vesselshall be performed in accordance with the Shipper's operating procedures. Remove old labels prior to filling, and re-label the packaging for the contents to be transported. The label shall include the actual gallonage of the content loaded. UN solution content must not exceed 230 gallons (870 liters).

b. Install the secondary lid. Nut and bolt threads should be lubricated with anti-seize to avoid galling. Hand tighten until the nuts or bolts are snug against the flange.

c. All secondary lid closure bolts shall be torqued to 75 [+10 -0] ft-lbs, alternating bolts on opposing sides of the lid. After reaching 100% of final torque, the torque should be checked one final time using clockwise or counter clockwise sequence around the flange.

d. Confirm that the containment system is properly assembled for shipment. Perform a leak test of the primary and secondary lid seals to show no detected leakage when tested to a sensitivity of $1 \times 10^{-3}$ ref-$cm^3$/sec per ANSI N14.5. If the primary lid has not been opened from the time of the last periodic test required by Section 8.1(c) or 8.2(g) (as indicated by tl presence of the tamper indicating devices located at the primary lid seal), this test may be waived for the primary lid only. After testing, install the port plug at each leak test port and tighten to 60 [ +10 -0] in-lbs.

e. Install outer lid. Nut and stud threads should be lubricated with anti-seize to avoid galling. The stud nuts should be hand tightened snug against the flange.

f. All outer lid stud nuts shall be tightened to 30 [+10 -0] ft-lbs, alternating stud nuts on opposing sides of the lid. After reaching 100% of final torque, torque should be checked one final time using a clockwise or counter sequence around the flange.

g. Install security seals and record their numbers.

h. Complete contamination survey in accordance with 10 CFR Part 71.87 (i) and (j).

i. Load the LR on the conveyance and secure per the Shipper's Operating Procedures. Shackles shall be removed or secured to top angle with nylon tie to prevent shackle from being used as tie down. Visually inspect all tie-down devices to confirm they are in place.

## *7.2 Procedures for Unloading the LR*

Unload the LR as follows:

a. Complete a receiving report per the Receiver's operating procedures and specifications.

b. Remove and record the package seal.

c. If the MVE feature is present and it is desired to check the annulus pressure or vent the annulus area as directed in Section 7.4, complete these functions before continuing.

d. Remove the outer lid from the LR.

e. Survey for radioactive contamination in the annulus area of the package. If contamination is present, decontaminate as required.

f. Remove the secondary lid by loosening and removing the secondary lid bolts. Care should be taken to avoid impacting the elbow fitting on the secondary lid flange (if present).

g. If the package has been stored filled for more than six months venting of the containment vessel is recommended prior to unloading. Venting can be accomplished using the quick disconnect fittings available on the fill port. Any venting should be performed using a filtered system. Packages must be unloaded within one year of filling.

h. Unload the containment vessel in accordance with the Receiver's operating procedures. A temporary draw pipe, of smaller diameter than the permanent draw pipe, may be inserted through the fill port identified in Detail D of drawing LR-SAR to unload the containment vessel. If the permanent draw pipe is suspected of being damaged, such as by experiencing reduced or no flow when unloading through the permanent draw pipe, then the package shall be emptied using the temporary draw pipe mentioned above, and the package maintained per SAR section 8.2(g).

i. Following unloading, the package should be decontaminated as is practical, and the lids secured in place for storage. Ali shipment labeling should be removed and replaced with markings that meet DOT requirements.

### *7.3 Preparation of Empty LR for Transport*

a. After initial usage, all-applicable steps set forth in Section 7.1.2 are required for transportation of the empty packaging, with the exception that the leak test required by 7.1.2 (d) can be waived if the heel contains less than an A2 quantity. A newly fabricated package that has never carried UN solution is exempted from the requirements of Section 7.

### *7.4 Use of the MVE Feature*

The outer lid of the LR may include an optional Manual Valve Enclosure (MVE) that allows the User to check the pressure of the package annulus space and to vent the annulus space if necessary.

a. Unless the package is being venting or the annulus pressure is being measured, the MVE valve should be closed.

b. If the MVE feature is present and it is desired to check the pressure within the annulus space, loosen and remove all bolts on the MVE lid. Connect any required equipment to the MVE valve and measure the package annulus pressure. Following the pressure measurement, disconnect all equipment and close the MVE valve. If the package annulus will be vented, continue to 7.4(c); otherwise, replace the MVE lid. Bolt threads should be lubricated with anti-seize to avoid galling. The bolts should be hand tightened snug against the MVE lid. All MVE lid bolts shall be tightened to 30 [+10 -0] ft.-lbs.

c. If the MVE feature is present and it is desired to vent the annulus space, loosen and remove all bolts on the MVE lid. The User should use a filtered system to vent the package annulus. Connect any required equipment to the MVE. If the venting system provides pressure regulation, the venting system pressure must be within the design pressure of the package (-11 to 30 psig external to the containment vessel). Open the MVE valve and vent the package annulus. Following venting, disconnect all

equipment and allow the package annulus to return to atmospheric pressure by opening the MVE valve to atmosphere. Close the MVE valve. Replace the MVE lid. Bolt threads should be lubricated with anti-seize to avoid galling. The bolts should be hand tightened snug against the MVE lid. All MVE lid bolts shall be tightened to 30 [+10 -0] ft.-lbs.

**ENCLOSURE 3**

"Security-Related Information" withheld from Packaging Safety Analysis Report for the Liqui-Rad (LR) Transportation Unit Package, Revision 9

Drawing LR-SAR, Revision 10, Sheets 1 through 4