

## Draft Guidance on Estradiol

This draft guidance, when finalized, will represent the current thinking of the Food and Drug Administration (FDA, or the Agency) on this topic. It does not establish any rights for any person and is not binding on FDA or the public. You can use an alternative approach if it satisfies the requirements of the applicable statutes and regulations. To discuss an alternative approach, contact the Office of Generic Drugs.

**Active Ingredient:** Estradiol

**Dosage Form; Route:** Film, extended release; transdermal

**Recommended Studies:** Three studies

1. Type of study: Bioequivalence (BE) study with pharmacokinetic (PK) endpoints  
Design: Single-dose, two-treatment, two-period crossover in vivo  
Strength: 0.1 mg/24 hr  
Subjects: Non-smoking, postmenopausal women with no contraindication to estrogen therapy

Additional comments:

- In this document, this dosage form is referred to as a transdermal delivery system (TDS) and includes products that may be described elsewhere or known as *patches* or *extended release films*.
- Unless otherwise justified, the estradiol TDS should be applied to the same anatomical site on all subjects, selected from among those recommended for dosing in the approved labeling for the reference listed drug (RLD) product, and worn for 3.5 days (84 hours). Applicants should randomize subjects to receive either the test or RLD product in a given study period. When possible, the TDS administered in the second study period should be applied to the same anatomical site as in the first study period, but on the contralateral side of the body.
- Contact of the TDS with the skin is essential for the in vivo performance of the TDS, and the PK may be altered when a TDS loses its adherence to the skin. Therefore, the adhesion of each TDS should be monitored and recorded throughout the PK study. The PK samples should be collected and analyzed from all subjects at all sampling times regardless of the adhesion scores of the TDS. Provisions should be included in the study protocol to ensure that deliberate actions with the intent to re-apply a detached area of the TDS, to apply pressure to the TDS, or to reinforce TDS adhesion with the skin (e.g., overlays) are avoided throughout the study.
- The applicant should follow FDA's current thinking in the guidance "Bioequivalence Studies with Pharmacokinetic Endpoints for Drugs Submitted Under an ANDA" for the design and conduct of the PK BE study.

**Analytes to measure (in appropriate biological fluid):** Estradiol in plasma. An average baseline correction is obtained by averaging the 3 pre-application sampling times (-1, -0.5 and 0 hours).

**Bioequivalence based on (90% CI):** Estradiol, using both baseline corrected and uncorrected data.

**Waiver request of in vivo testing:** The 0.025 mg/24 hr, 0.0375 mg/24 hr, 0.05 mg/24 hr, and 0.075 mg/24 hr strength of the TDS may be considered for a waiver of in vivo BE testing based on (1) an acceptable BE study with the 0.1 mg/24 hr strength TDS, (2) acceptable in vitro dissolution testing of all strengths, and (3) proportional similarity of the TDS formulations across all strengths.

NOTE: The proportional similarity of the TDS formulation across all strengths means i) that the amounts of active and inactive ingredients per unit of active surface area are identical for the different strengths of the test product, and ii) that the ratios of the active surface areas of each strength of the test product compared to the 0.1 mg/24 hr strength of the test product are the same as the corresponding ratios for the active surface areas of each strength of the RLD product compared to the 0.1 mg/24 hr strength of the RLD product.

**Dissolution test method and sampling times:** Comparative dissolution testing should be conducted on 12 dosage units each, of all strengths of the test and RLD products. Information on a dissolution method for this drug product can be found on the FDA Dissolution Methods web site, accessible at: <http://www.accessdata.fda.gov/scripts/cder/dissolution/>.

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2. Type of study: Adhesion study  
Design: Single-dose, two-treatment, two-period crossover in vivo  
Strength: 0.1 mg/24 hr  
Subjects: Non-smoking, postmenopausal women with no contraindication to estrogen therapy

Additional comments:

- The applicant may elect to evaluate the PK BE (study 1) and the adhesion (study 2) in a single study with a combined purpose, or in independent studies. In either case, the studies should be adequately powered to evaluate the BE, and independently, the comparative assessment of adhesion.
- The applicant should follow FDA's current thinking in the guidance "Assessing Adhesion With Transdermal and Topical Delivery Systems for ANDAs" for the design and conduct of the independent adhesion study or the combined study to evaluate both PK BE and adhesion.

3. Type of study: Skin irritation and sensitization study  
Design: Randomized, evaluator-blinded, within-subject repeat in vivo  
Strength: 0.025 mg mg/24 hr  
Subjects: Non-smoking, postmenopausal women with no contraindication to estrogen therapy

Additional comments:

- All test articles (i.e., 0.025 mg/24 hr test product<sup>1</sup>, 0.025 mg/24 hr RLD product, optional vehicle TDS<sup>2</sup> and optional negative control<sup>3</sup>) should be applied simultaneously to each subject at different positions on an application site recommended in the approved labeling for the RLD product.
- Sequential TDS applications should be made to the same application site every 84 hours for a total of 21 consecutive days. The TDS applied on Day 18 should be removed on Day 22.
- The applicant should follow FDA's current thinking in the guidance "Assessing the Irritation and Sensitization Potential of Transdermal and Topical Delivery Systems for ANDAs" for the design and conduct of the skin irritation and sensitization study.

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**Additional comments relating to all studies:**

In addition to the recommendations in the general guidances referenced above, and the product specific recommendations related to the individual studies, the following product specific recommendations should be considered.

- As a safety precaution, the subject's seated blood pressure should be evaluated at all visits.
- Inclusion Criteria (the applicant may add additional criteria):
  - a. Non-smoking, postmenopausal female subjects with no contraindication to estrogen therapy. "Postmenopausal" is defined as 12 months of spontaneous amenorrhea or 6 months of spontaneous amenorrhea with serum FSH levels > 40 mIU/ml or 6 weeks postsurgical bilateral oophorectomy with or without hysterectomy.
  - b. Baseline systolic blood pressure should be no greater than 140 mm Hg and diastolic blood pressure no greater than 80 mm Hg.

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<sup>1</sup> The test TDS evaluated should be the actual TDS to be marketed.

<sup>2</sup> The optional vehicle TDS should contain all of the inactive ingredients in the test product and be identical to the test product in every manner except for the absence of the active ingredient.

<sup>3</sup> An example of the optional negative control treatment is an occlusion cover or device with normal saline applied on a polyester pad under the cover or within the device chamber.

- c. Subjects >40 years have documentation of a negative screening mammogram (obtained at screening or within 9 months of study enrollment) and a normal clinical breast examination prior to enrollment in study.
- d. Subjects with an intact uterus have baseline vaginal ultrasonography demonstrating inactive endometrial lining with endometrial thickness less than 4 mm.
- Exclusion Criteria (the applicant may add additional criteria):
  - a. Male subject.
  - b. Premenopausal, perimenopausal, pregnant or lactating subject.
  - c. Undiagnosed abnormal genital bleeding.
  - d. Known, suspected, or history of breast cancer.
  - e. Known or suspected estrogen-dependent neoplasia.
  - f. History of endometrial cancer or risk factors for endometrial cancer.
  - g. Subject with tobacco use or body mass index (BMI)  $\geq 90$ .
  - h. Active deep venous thrombosis, pulmonary embolism, or a history of these conditions.
  - i. High risk of venous thrombosis (VTE) or arterial thrombosis (ATE).
  - j. Active arterial thromboembolic disease (e.g., stroke and myocardial infarction), or a history of these conditions.
  - k. Anaphylactic reaction or angioedema with the RLD product.
  - l. Liver impairment or disease.
  - m. Protein C, protein S, or antithrombin deficiency, or other thrombophilic disorders.
  - n. History of cholestatic jaundice, hypertension, coronary heart disease or other serious heart problems, diabetes, hypercholesterolemia, hypercalcemia, hypoparathyroidism, hypertriglyceridemia, systemic lupus erythematosus, renal impairment, residual endometriosis post-hysterectomy, asthma, epilepsy, migraine, porphyria, hepatic hemangiomas.
  - o. History of narcotic abuse, drug abuse or alcoholism.
  - p. Within 6 months prior to dosing, estrogen pellet therapy or progestin injectable drug therapy.
  - q. Within 3 months prior to dosing, progestin implants and estrogen alone injectable drug therapy.
  - r. Within 8 weeks prior to dosing, oral estrogen and/or oral or intrauterine progestin therapy.
  - s. Within 4 weeks prior to dosing, transdermal estrogen alone or transdermal estrogen/progestin products.

- t. Within 1 week prior to dosing, vaginal hormonal products (rings, creams, gels).
- u. Within 4 to 6 weeks before surgery of the type associated with an increased risk of thromboembolism, or during periods of prolonged immobilization.
- v. Taking thyroid hormone replacement therapy.
- w. Taking inducers of CYP3A4 such as St. John's wort, anticonvulsants, phenylbutazone, rifampin, rifabutin, nevirapine and efavirenz.
- x. Taking inhibitors of CYP3A4 such as erythromycin, clarithromycin, ketoconazole, itraconazole, ritonavir, nelfinavir and grapefruit juice.
- A listing of the prescription and over-the-counter drug products that are contraindicated during the study should be provided, such as:
  - a. Antihypertensives and pressor agents.
  - b. Estrogens, other than study medication.