INTRODUCTION
A sample of the developer is first acidified to a given pH. Formalin is then added to react with the ethylenediamine to release hydronium ions (H$_3$O$^+$) as shown.

$$\text{H}_3\text{N(CH}_2\text{)}_2\text{NH}_3^+ + \text{CH}_2\text{O} \rightarrow \text{H}_2\text{N(CH}_2\text{)}_2\text{NH}_2 + \text{H}_3\text{O}^+$$

The hydronium ions that are released are then titrated with base to give an indirect measure of ethylenediamine.

This method requires handling potentially hazardous chemicals. Consult the Material Safety Data Sheet for each chemical before use. MSDS’s are available from your chemical supplier.

RELIABILITY
The calibration curve was calculated from the 40 results obtained by two analysts who analyzed standard laboratory mixes for the reversal processes. The mixes contained from 1.50 to 3.40 g/L ethylenediamine. The volumes of base required in the titrations were used to calculate, by the method of least squares, the best straight line for the universal calibration curve. The equation for this line is found under Calculations. The 95 percent confidence limits for an individual determination are ± 0.04 g/L of ethylenediamine.

SPECIAL APPARATUS
- pH Meter
- Reference Electrode, Ceramic Junction, Calomel, Corning No. 476002, Beckman No. 38423 or equivalent (Filled with 3.5 M potassium chloride solution)
- Indicator Electrode, glass (pH), Rugged Bulb, Corning No. 476024 or equivalent

Note: Use pipets and volumetric glassware meeting the “Class A” definition by the National Institute of Standards and Technology (NIST).

REAGENTS
Use ACS Reagent Grade reagents unless specified otherwise.
- Foamex
- 1.0 N Sulfuric Acid, H$_2$SO$_4$
- 0.1 N Sodium Hydroxide, NaOH (standardized to 4 decimal places)
- 37.5 percent Formaldehyde solution, pH 3.9

PROCEDURE
Meter Preparation

Titration
1. Pipet 50.0 mL of sample into a 250-mL beaker.
2. Immerse the electrode assembly in the sample and add sufficient distilled water to cover the tips of the electrodes.
3. Add 1 drop of Foamex, and stir the solution with a magnetic stirrer.
4. Add, from a squeeze bottle or buret, 1.0 N sulfuric acid to attain a pH equal to or slightly less than 3.8. (This volume does not have to be measured.)
5. Adjust the solution to pH 3.90 with standardized 0.1 N sodium hydroxide from a squeeze bottle or an eyedropper.
6. Add 25 mL of 37.5 percent formaldehyde solution, pH 3.9, from a tip-up pipet.
7. Titrate to pH 3.90 with standardized 0.1 N sodium hydroxide.

Calculation

Ethylenediamine, g/L = $1.16(N \text{ NaOH})(mL \text{ NaOH}) + 0.26$