

**STATUS OF CEOG RVWG
REACTOR PRESSURE VESSEL
WELD PROPERTIES EVALUATION**

**DETERMINATION OF BEST-ESTIMATE
COPPER AND NICKEL CONTENT
IN CE FABRICATED VESSEL WELDS**

**REACTOR VESSEL WORKING GROUP
C-E OWNERS GROUP
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STATUS OF CEOG RVWG REACTOR PRESSURE VESSEL WELD PROPERTIES EVALUATION

Presentation Outline

- Background
- Database Review
- Process Flow Diagrams
 - Data Pedigree Process
 - Data Analysis Process
- Generic Data
- Data Analysis Examples

REACTOR PRESSURE VESSEL WELD PROPERTIES EVALUATION

BACKGROUND

- CEOG RVWG established in 1995 to address RVI issues
- RVWG Weld Properties Evaluation Task initiated 8/1/95
- Focus on best-estimate copper and nickel content in CE fabricated welds
- Task scope includes weld deposit chemistry database, guidelines for data pedigree and data analysis processes, and best-estimate Cu and Ni using pedigreed data and analysis guidelines
- 3/96 meeting described RVWG task scope, data sources and data pedigree process
- 7/96 meeting discussed preliminary database results, data pedigree results and data analysis concepts
- RVWG Weld Properties Evaluation Task is scheduled for completion by 12/31/96

OBJECTIVES OF PRESENTATION

- Update since July 1996
- Review data pedigree process
- Describe and illustrate best-estimate determination process

Database Description

- 1838 data entries for weld deposit analysis
- 66 unique heats or combinations of heats (automatic submerged arc and manual arc electrode heats used in beltline of CE fabricated vessels)

54 new entries obtained from EPRI RPVDATA

Database Description (continued)

Database Structure

Weld Deposit Information-

Electrode heat number, flux type and lot number, number of electrodes, and use of Ni-200 (Y/N)

Example: 33A277, Linde 0091 lot 3922, one electrode, no Ni-200

Data Source Information-

CE contract and job number, weld seam identification, analysis number and date, data supplier, and RVG source document number and record type

Example: Contract #72167, job #96347, seam 9-203B, analysis #D8778 dated 6/22/70 from CE D-log, RVG#12161 for an in-process weld deposit analysis

Deposit Analysis-

As-reported values of Cu, Ni, Si, P, S, Mn, Mo, Sn, C, Co, Cr, V, Al, Sb, Be, As, Mg, B, Nb, Ti, Ta, Zn, N, Pb, W, and Zr

Pedigree Assessment-

Determination as valid, indeterminate or invalid; brief explanation of basis for indeterminate or invalid determination

Example: Invalid; Record from PR-EDB duplicates C-E D4956

Notes-

Memo field containing additional information

Example 1: Sample removed from cap of weld seam *[notation from D-log]*

Example 2: Sample Q1-G, Bottom-Base Metal *[sample location description from test report]*

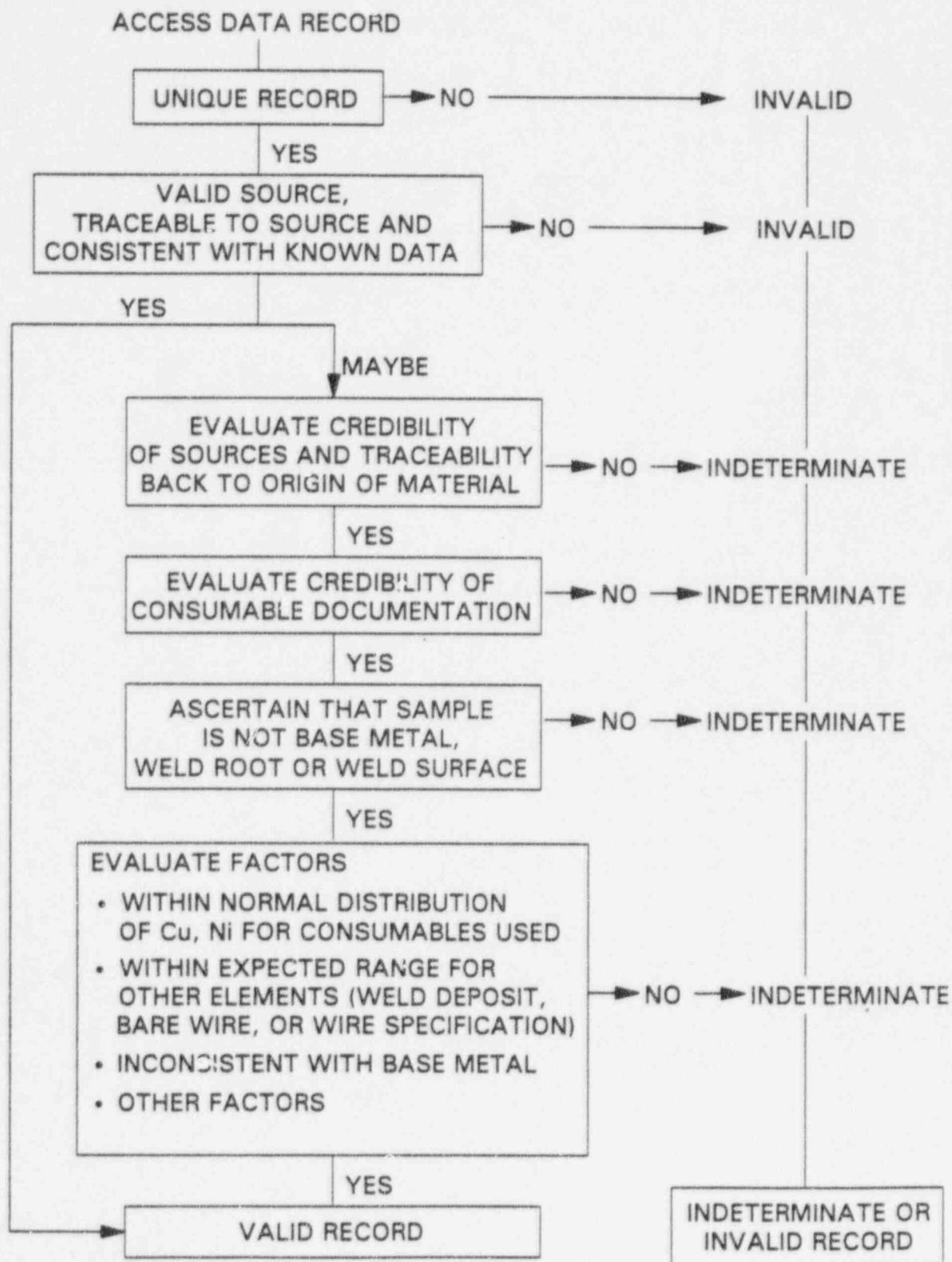
Example 3: Center Bead 8 1/4" from OD, Analysis by OES *[notation from D-log and test report]*

PROCESS FLOW DIAGRAMS

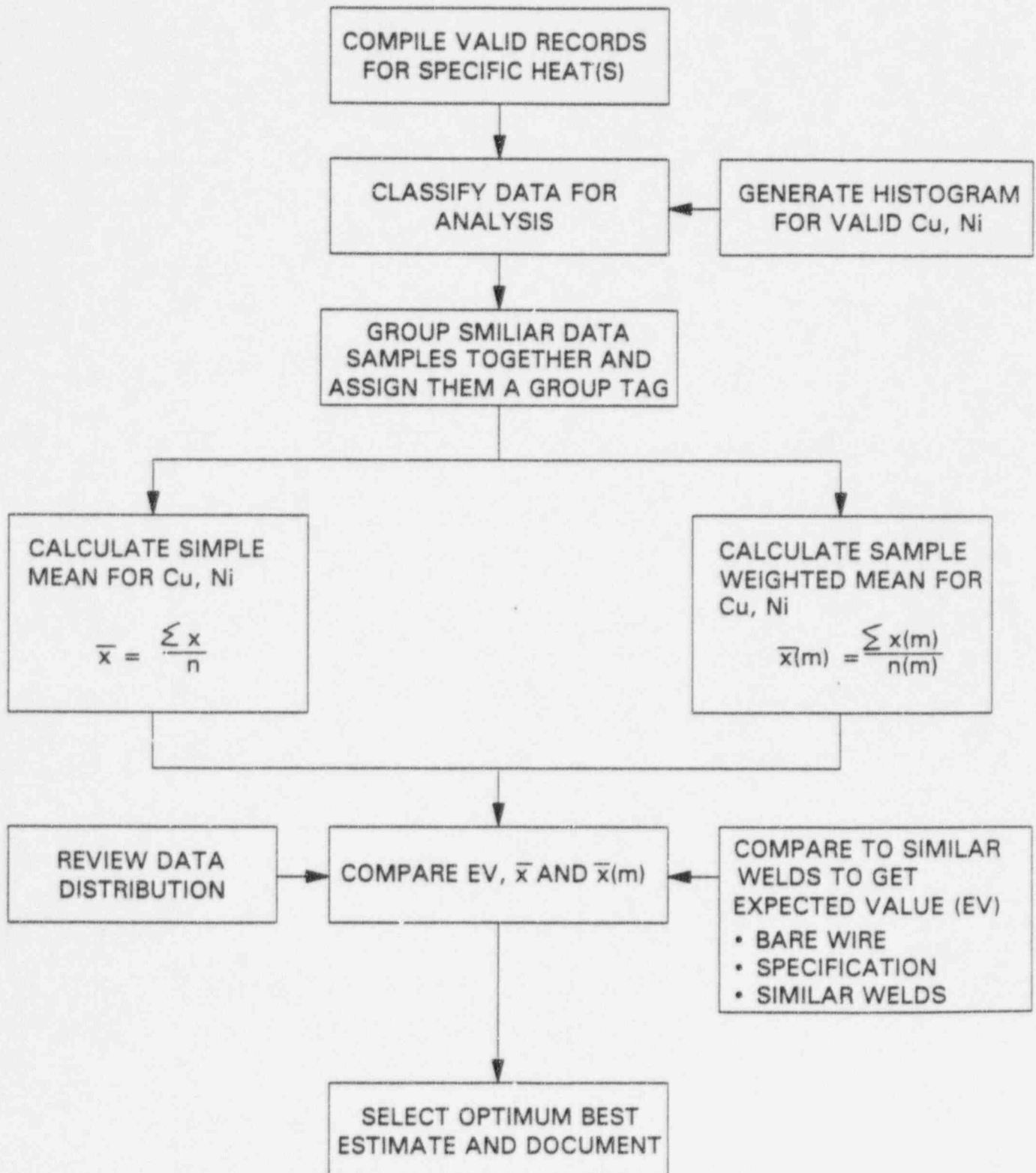
Data Pedigree Process

Data Analysis Process

CEOG RVWG DATA PEDIGREE PROCESS



CEOG RVWG WELD DEPOSIT DATA ANALYSIS PROCESS



Data Analysis Process

Modified Best Estimate Techniques

Simple Mean:

- derive mean Cu and Ni, $x(m)$, for all the valid data for each individual heat

Sample-Weighted Mean:

- derive mean Cu or Ni, $x(m)$, for each unique weld sample
- calculate the modified mean as the sum of the sample means divided by the number of unique welds

Coil-Weighted Mean (Copper only):

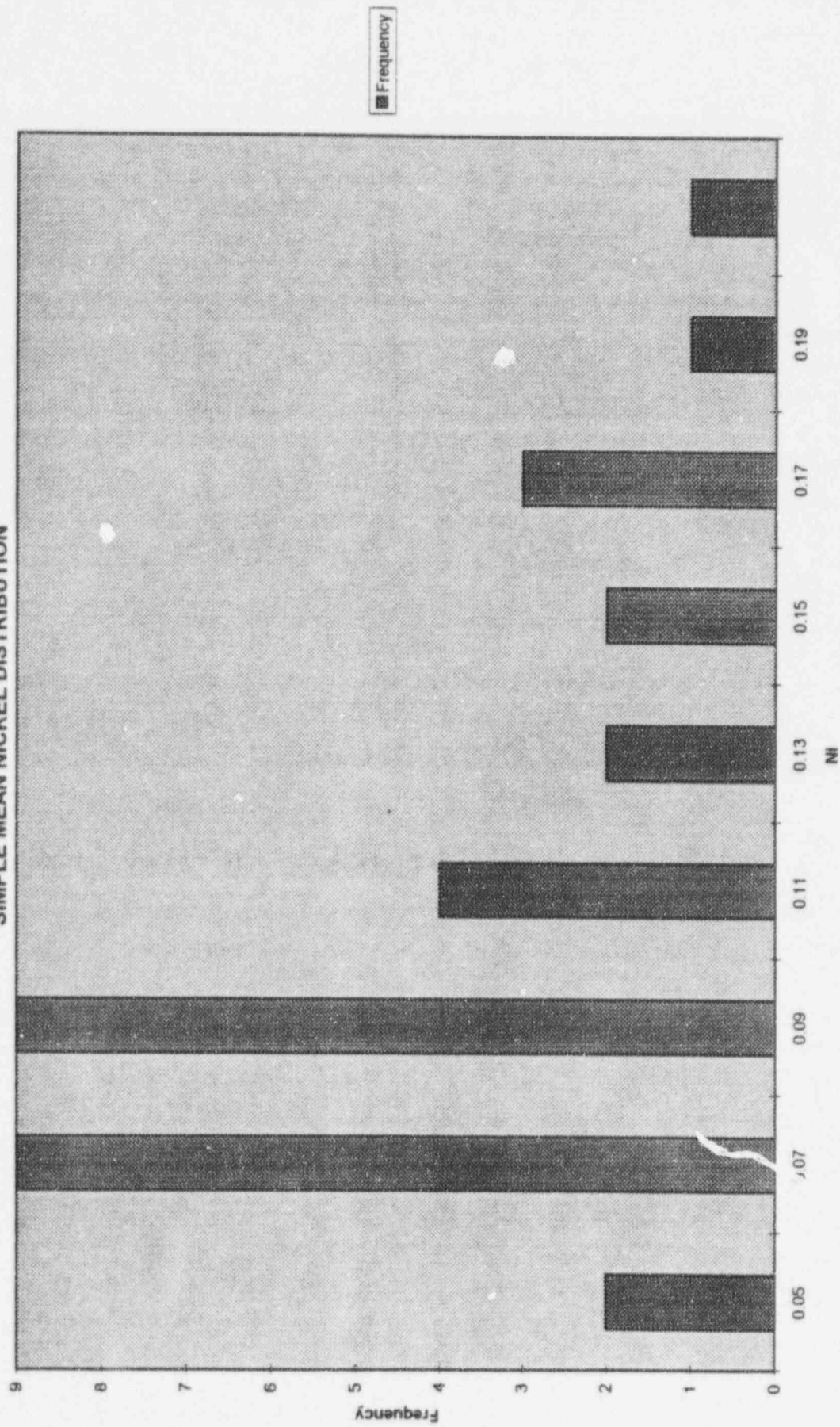
- estimate the number of coils used for each unique weld
- weight Cu measurements based on the number of coils represented in unique welds
- calculate the modified mean as the sum of the coil-weighted measurements divided by the number of coils

Generic Copper And Nickel

Weld Deposit Nickel Content for Low Nickel Wire Heats

- CE fabricated welds using Mn-Mo and Mn-Mo-Ni coiled electrodes
- Database for CE fabricated weld chemistries contains 33 low nickel heats with nickel analyses
- Only small mean nickel differences between suppliers, hence the data were pooled (see histogram)
- Range of data is 0.0375% to 0.20%.
- Mean nickel for 33 heats is 0.095%
- 0.095% is a reasonable best estimate for nickel for all welds fabricated using low nickel wire

FIGURE 1
SIMPLE MEAN NICKEL DISTRIBUTION



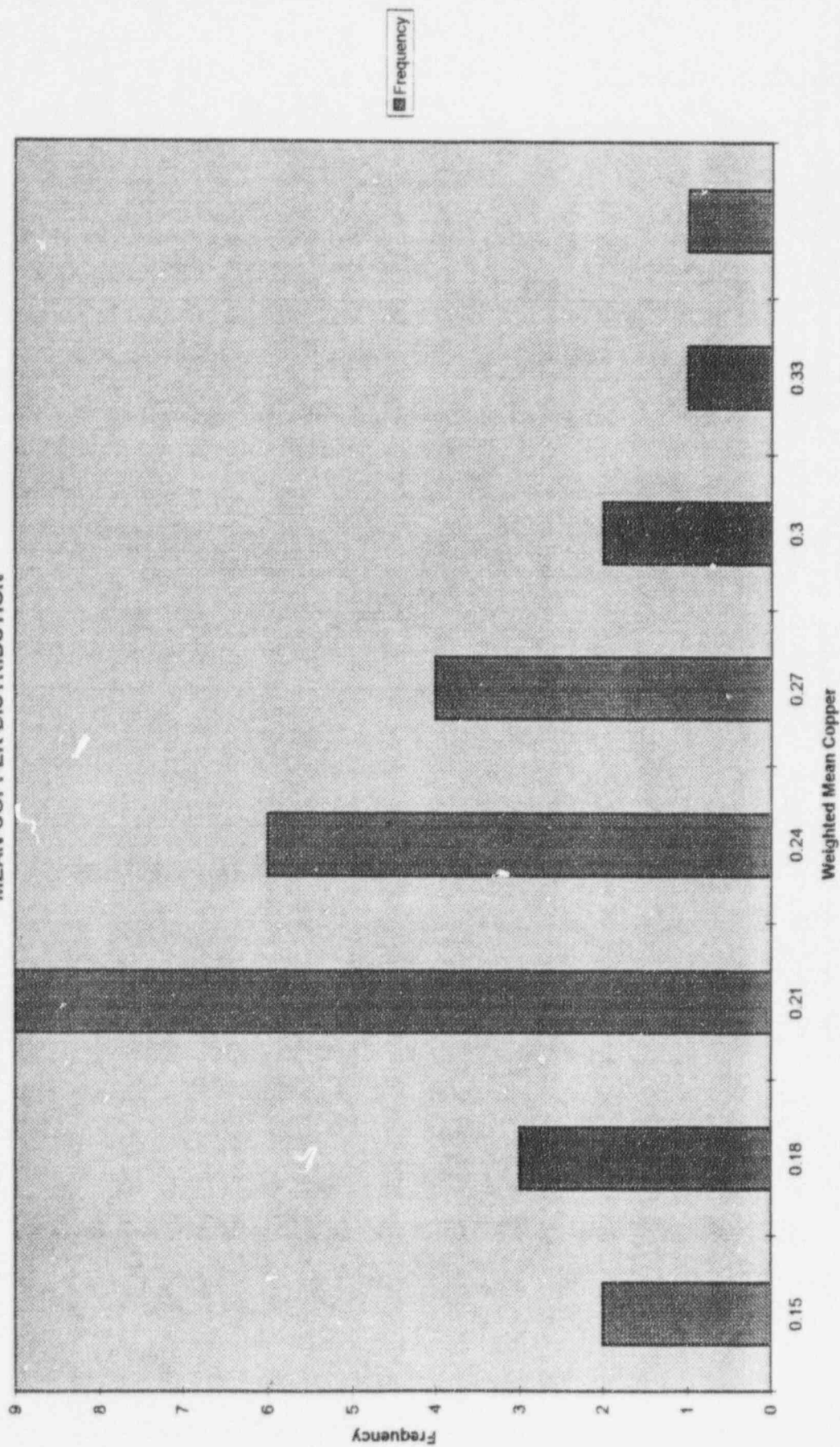
Generic Copper And Nickel

Weld Deposit Copper Content For Copper Coated Wire Heats

- The copper will vary in a weld deposit fabricated using a copper coated electrode because of variations in the thickness of the copper coating
- A generic value of copper useful to help determine whether a set of limited measurements are a good estimate of the mean copper for that heat
- Used the weighted mean for 28 copper coated heats (see histogram)
- Obtained mean of 0.219%.

FIGURE 2

MEAN COPPER DISTRIBUTION



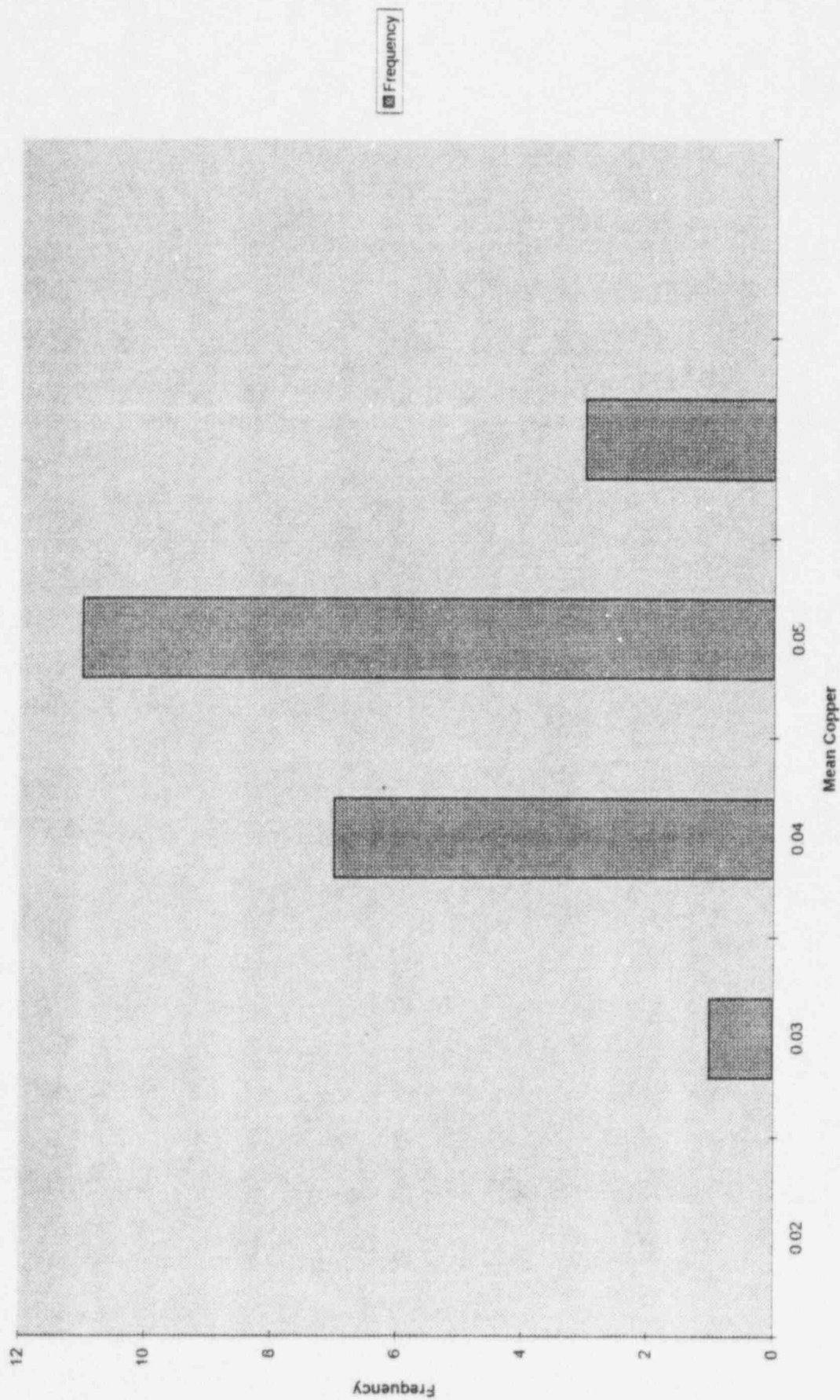
Generic Copper And Nickel

Weld Deposit Copper Content For Non-Coated Wire Heats

- Copper content will come from the 'bare' wire plus dilution from the surrounding base metal
- A generic value of copper useful to help determine whether a set of limited measurements are a good estimate of the mean copper for that heat
- Used the weighted mean for 22 non-coated heats (see histogram)
- The mean of the data is 0.043%.

FIGURE 3

Simple Mean Copper Distribution



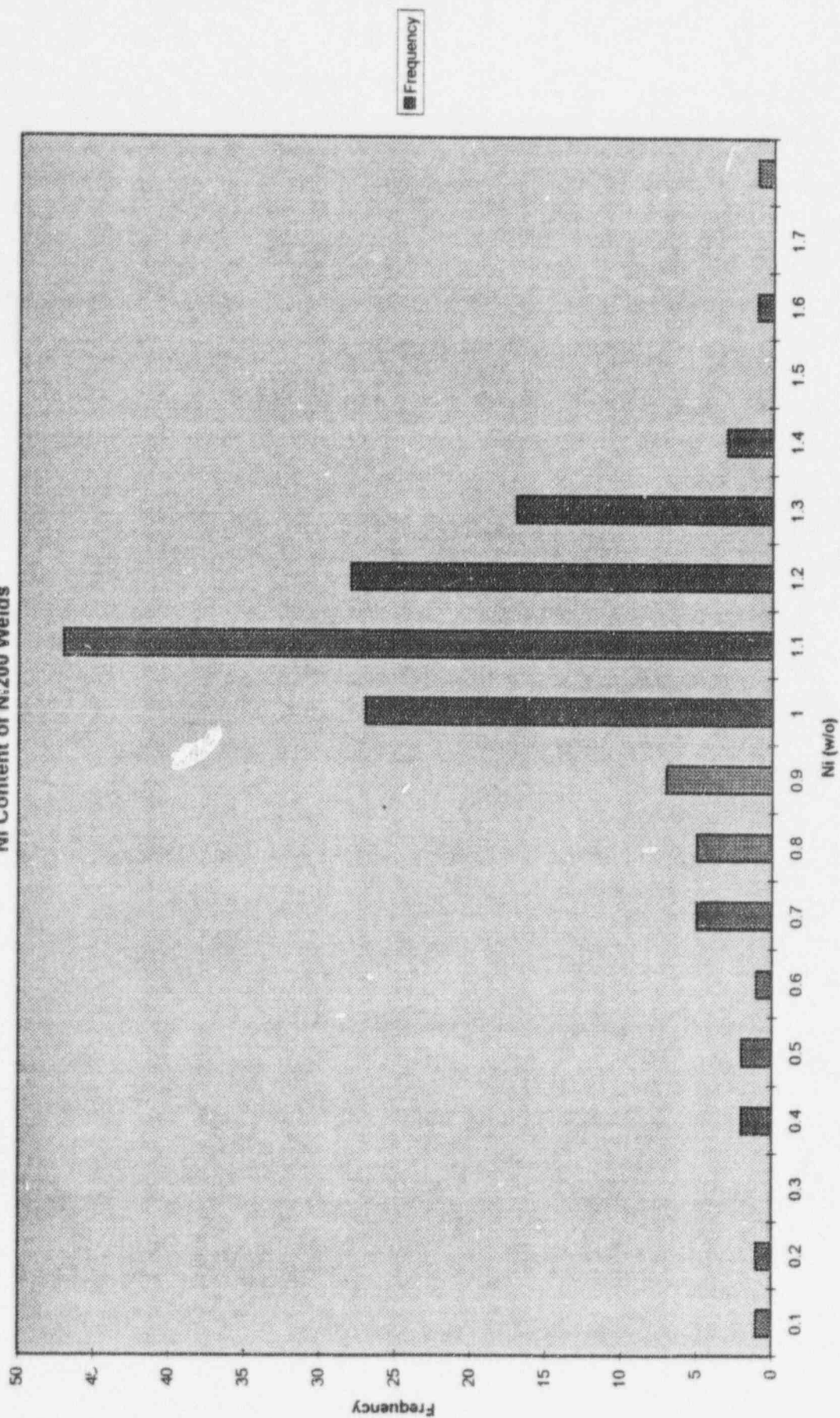
Generic Copper And Nickel

Weld Deposit Nickel Content For Nickel Addition Welds

- CE fabricated some reactor vessel welds using a combination of a Mn-Mo electrode and a Ni-200 cold wire feed
- 148 nickel measurements available (valid or indeterminate pedigree)
- The data range from 0.08% to 1.78% Ni (see histogram)
- Obtained mean nickel of 1.025% for nickel addition welds

FIGURE 4

Ni Content of Ni200 Welds



Description of Worksheet

- A worksheet was created for each weld wire heat or combination of heats
- Lists each valid, indeterminate and invalid weld deposit chemical analysis record located for that heat
- Data extracted from the RVWP database and included in the worksheet for each individual analysis:
 - Copper and nickel content
 - Source [Analysis / Report No.]
 - Pedigree
 - Source Identification number
- Information added to the worksheet:
 - Group Tag
 - Bare wire analysis
 - Wire vendor [supplier]
- Worksheet presents results of two calculations for mean Cu and Ni:
 - Simple mean of valid measurements
 - Sample-weighted mean for valid measurements

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