CONF 870598--1-Abst

MOTOR CURRENT SIGNATURE ANALYSIS FOR DETERMINING OPERATIONAL READINESS OF MOTOR-OPERATED VALVES (MOVs)*

R. C. Kryter
H. D. Haynes

Oak Ridge National Laboratory
Oak Ridge, Tennessee

CONF-870598--1-Abst.

DE87 009830

Abstract

Motor current signature analysis (MCSA) is a novel diagnostic process for condition monitoring of electric-motor-driven mechanical equipment (e.g., pumps, motor-operated valves, compressors, and processing machinery). The MCSA process identifies, characterizes, and trends over time the instantaneous load variations of mechanical equipment in order to diagnose changes in the condition of the equipment (e.g., due to degradation or service wear), which, if allowed to continue, may lead to failure. It monitors the instantaneous variations (noise content) in the electric current flowing through the power leads to the electric motor that drives the equipment. The motor itself thereby acts as a transducer, sensing both large and small, long-term and rapid, mechanical load variations and converting them to variations in the induced current generated in the motor windings. This motor current noise signature is detected, amplified, and further processed as needed to examine its time domain and frequency domain (spectral) characteristics.

The operational principles of MCSA and the nonintrusive data collection apparatus and procedure used with MOVs will be described. Data collected from MOVs in both laboratory and in-plant environments will also be shown to illustrate the ability of MCSA to "see" the detailed inner workings of the valve and operator and thus to detect degraded performance at an incipient stage.

---

* Research sponsored by the Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission under Interagency Agreement DOE 0551-0551-A1 with the U.S. Department of Energy under Contract DE-AC05-84OR21400 with the Martin Marietta Energy Systems, Inc.

Motor Current Signature Analysis for Determining Operational Readiness of Motor-Operated Valves (MOVs)

R. C. Kryter
H. D. Haynes

Oak Ridge National Laboratory
Oak Ridge , Tennessee

Fourth Conference on Utility Experience in Reactor Noise Analysis
Hartford , Ct. May 12–14 , 1987

THIS PRESENTATION WILL COVER THE FOLLOWING TOPICS :

- NPAR PROGRAM OBJECTIVES
- MOTOR-OPERATED VALVE (MOV) OPERATIONAL PARAMETERS STUDIED
- EQUIPMENT USED AND TEST METHOD
- LABORATORY TEST RESULTS
- NUCLEAR PLANT MOV TEST RESULTS
- MOTOR CURRENT SIGNATURE ANALYSIS (MCSA) BENEFITS AND APPLICATIONS

THE NUCLEAR PLANT AGING RESEARCH (NPAR) PROGRAM APPROACH CONSISTS OF THREE MAJOR WORK PHASES

PHASE I
- COMPILING BACKGROUND INFORMATION ON SELECTED COMPONENTS OR SYSTEMS
- IDENTIFYING PARAMETERS POTENTIALLY USEFUL FOR DETECTING AND TRENDING DEGRADATIONS

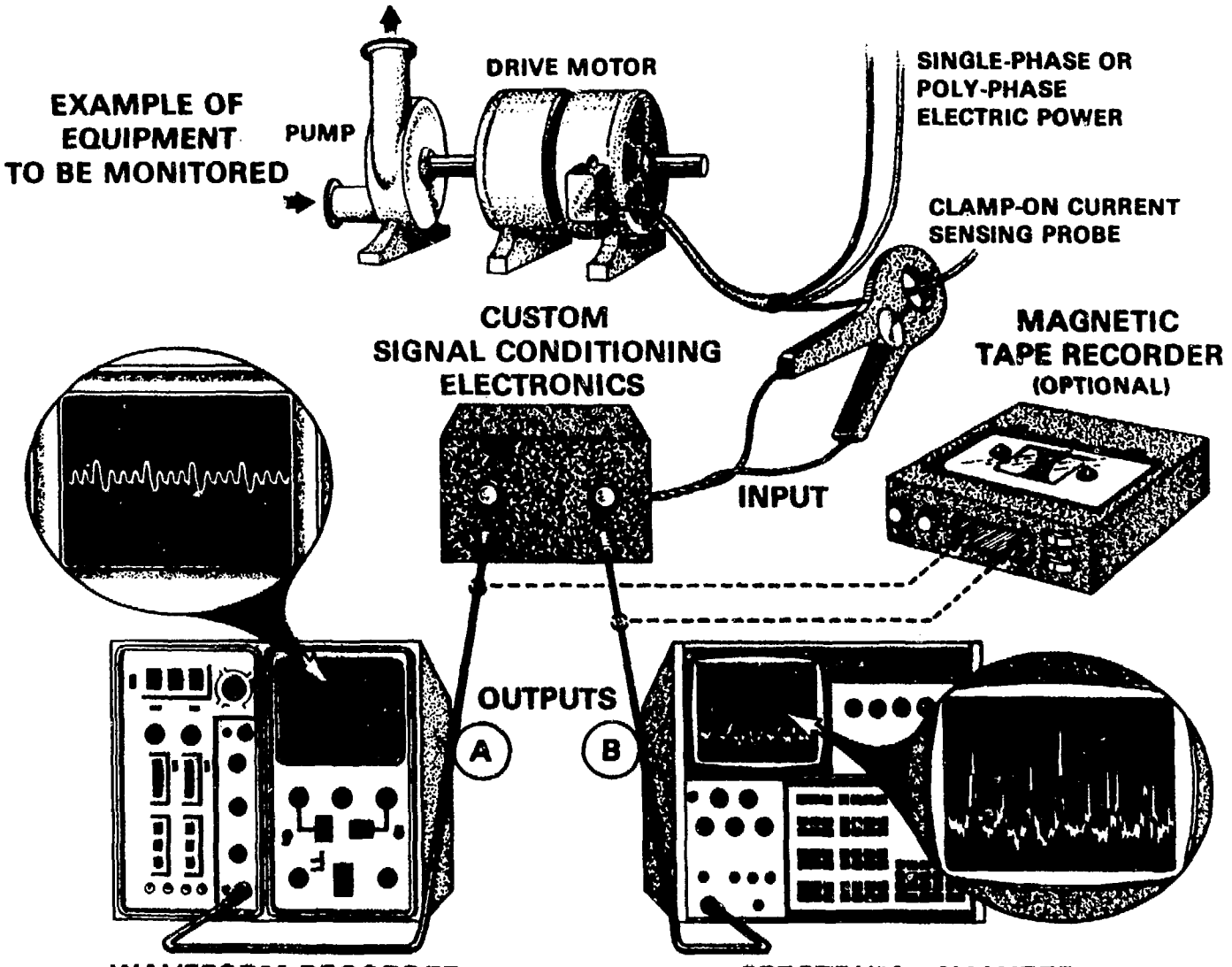
PHASE II
- PERFORMING IN-SITU EVALUATIONS OF AGED EQUIPMENT
- EVALUATING DIAGNOSTIC MONITORING TECHNIQUES
- PROVIDING RECOMMENDATIONS FOR SPECIFIC INSPECTION AND CONDITION MONITORING PRACTICES

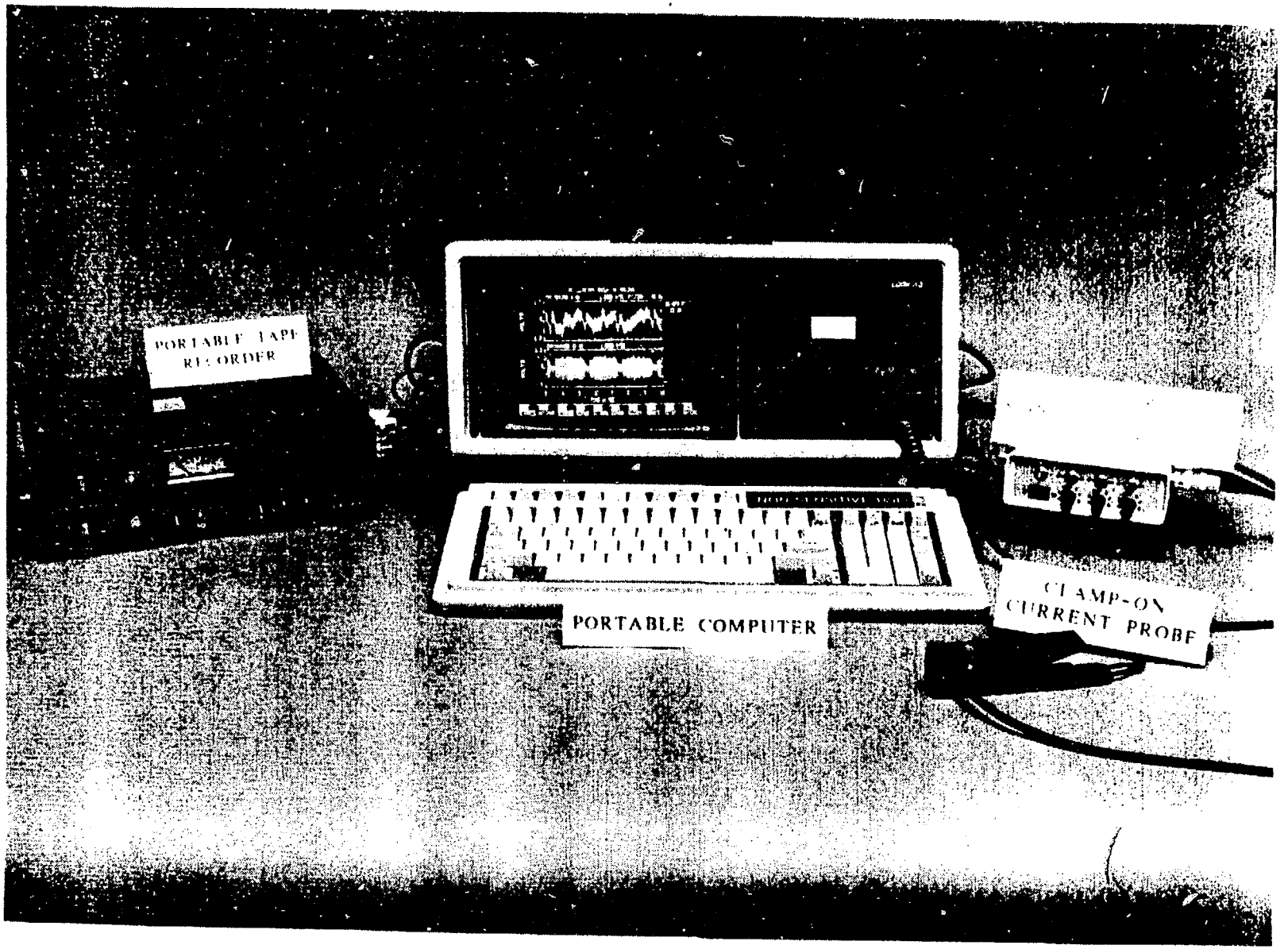
PHASE III
- DISSEMINATING AND APPLYING RESULTS

EIGHT MOTOR-OPERATED VALVE OPERATIONAL PARAMETERS WERE EVALUATED FOR THEIR CONDITION MONITORING ABILITIES

PARAMETERS STUDIED	EQUIPMENT USED
1. MOTOR CURRENT	MCSA EQUIPMENT
2. VALVE STEM POSITION	LVDT
3. VALVE STEM VELOCITY	LINEAR VELOCITY TRANSDUCER
4. VALVE STEM STRAIN	STEM-MOUNTED STRAIN GAGE
5. TORQUE AND LIMIT SWITCH ACTUATIONS	CIRCUIT CONTINUITY
6. INTERNAL AND EXTERNAL MOTOR TEMPERATURES	THERMOCOUPLES
7. VIBRATION	ACCELEROMETERS
8. TORQUE SWITCH POSITION	ANGULAR DISPLACEMENT TRANSDUCER

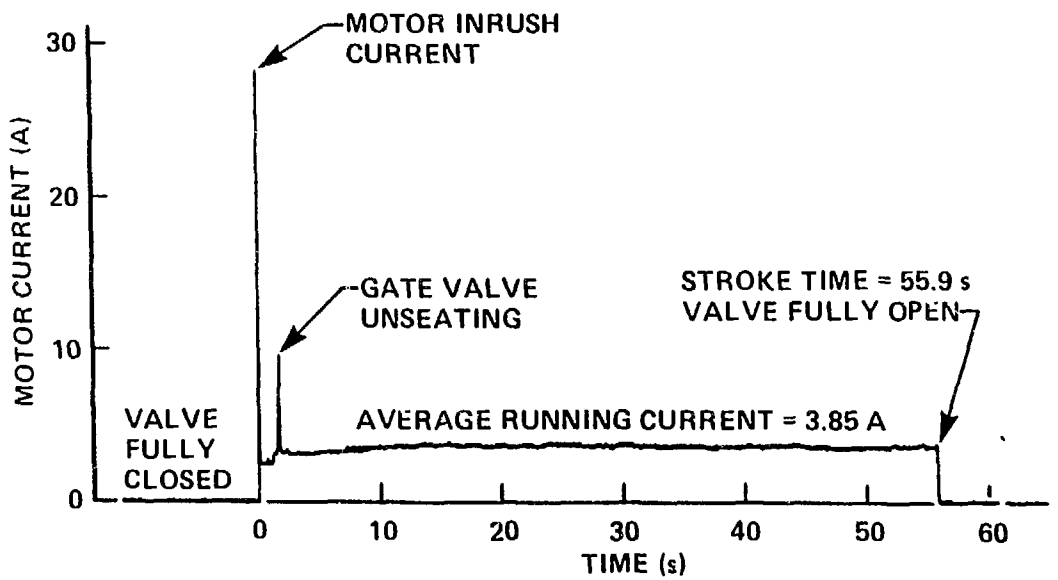
87-6647


EXAMPLE OF EQUIPMENT TO BE MONITORED
PUMP
DRIVE MOTOR
SINGLE-PHASE OR POLY-PHASE ELECTRIC POWER
CLAMP-ON CURRENT SENSING PROBE
CUSTOM SIGNAL CONDITIONING ELECTRONICS
MAGNETIC TAPE RECORDER (OPTIONAL)
INPUT
OUTPUTS
A
B
WAVEFORM RECORDER
(DIGITAL OSCILLOSCOPE)
A SIGNAL OPTIMIZED FOR TIME-DOMAIN ANALYSIS
SPECTRUM ANALYZER
(FOURIER TRANSFORM COMPUTER)
B SIGNAL OPTIMIZED FOR FREQUENCY-DOMAIN ANALYSIS


PORTABLE TAPE RECORDER
PORTABLE COMPUTER
CLAMP-ON CURRENT PROBE

ORNL–DWG 87–3945 ETD

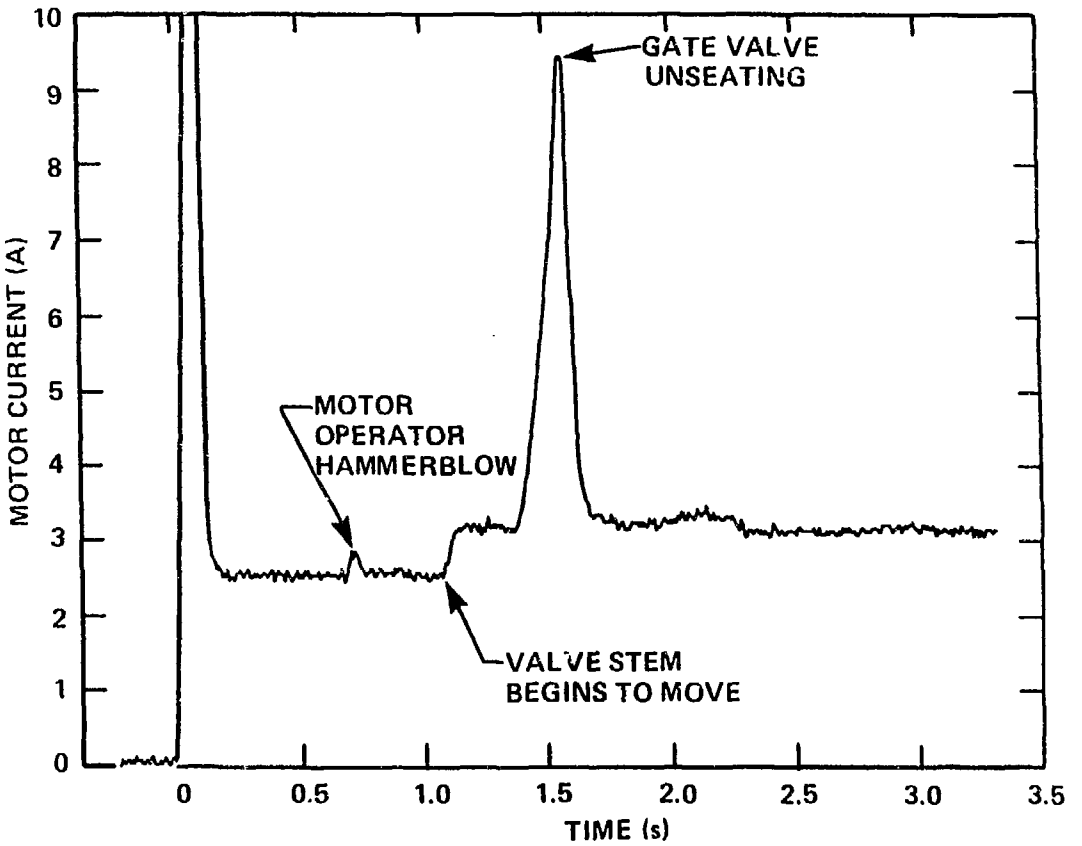
A MOTOR–OPERATED VALVE STROKE CAN BE CHARACTERIZED BY A MOTOR CURRENT SIGNATURE



ornl

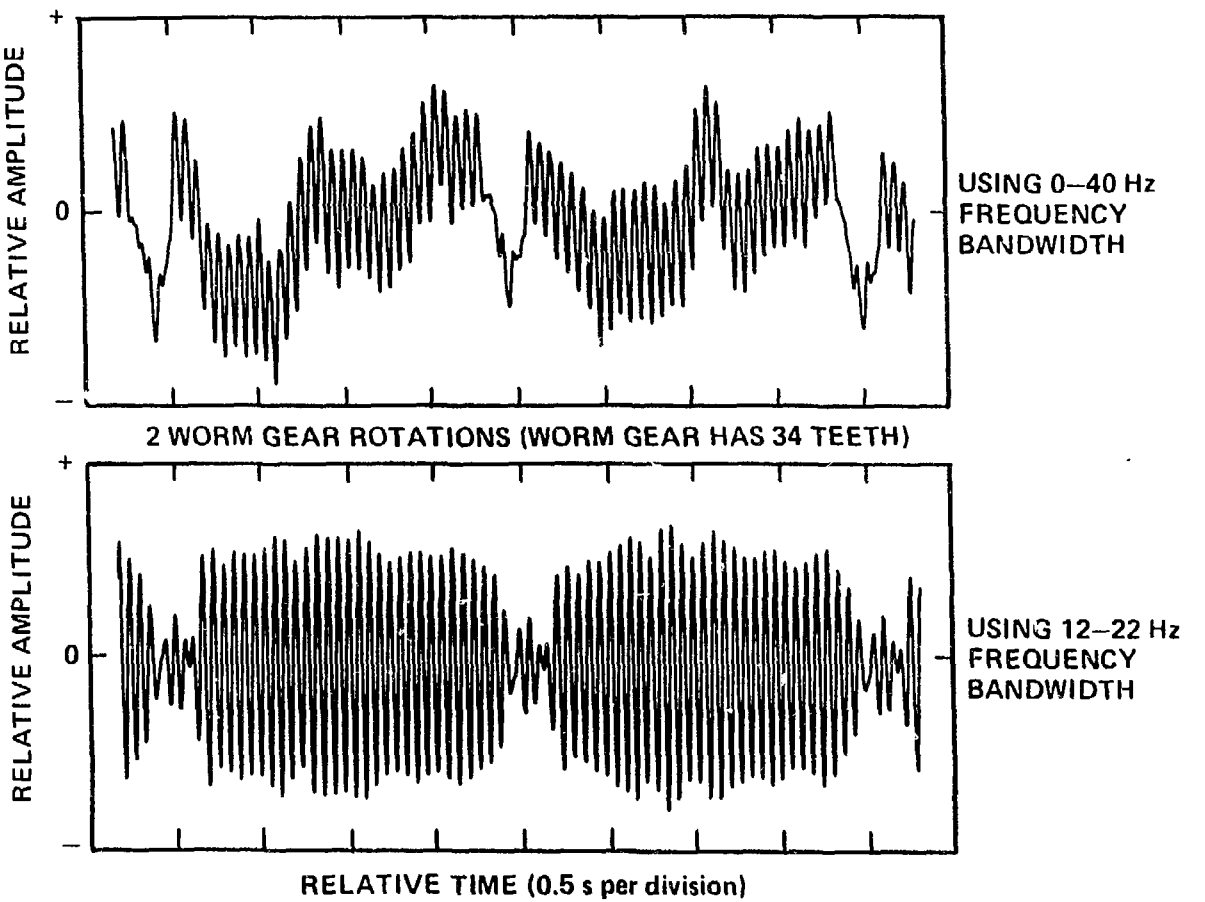
ORNL–DWG 87–3946 ETD

MOTOR CURRENT SIGNATURES CAN BE USED TO IDENTIFY TRANSIENT EVENTS WITHIN THE VALVE AND OPERATOR



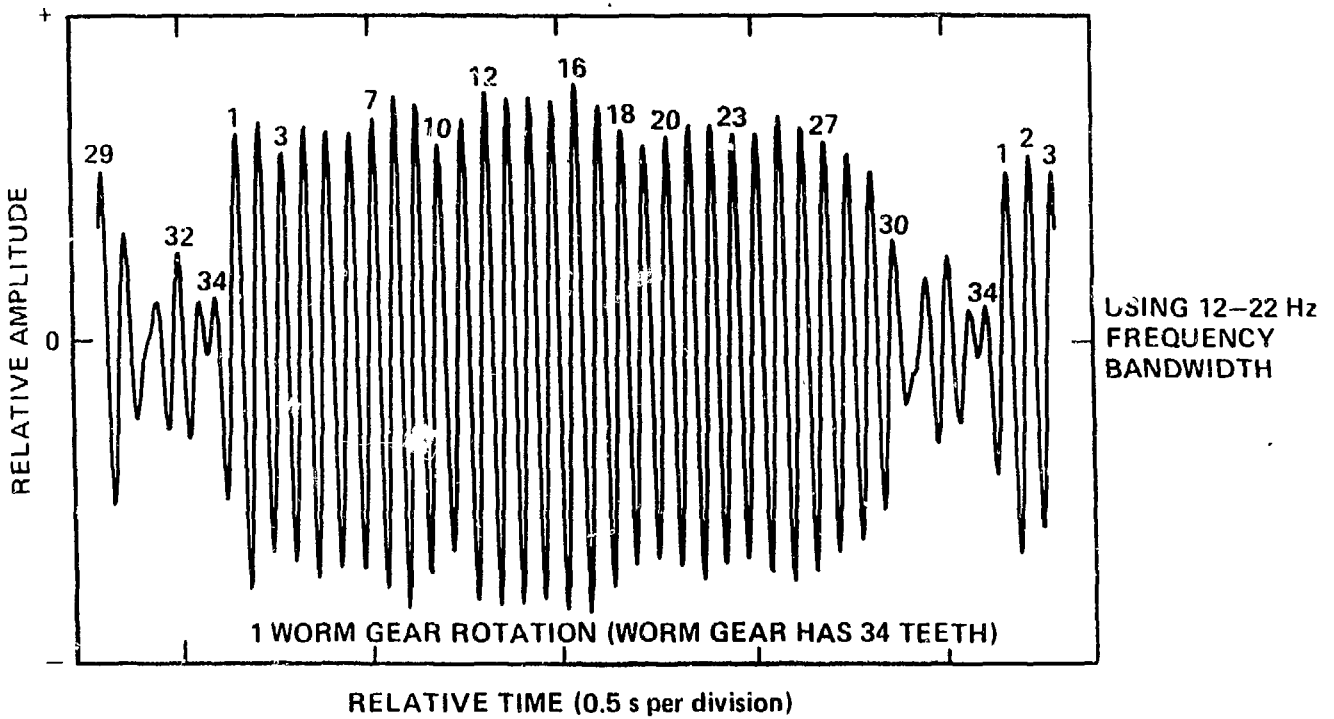
ornl

PERIODIC WAVEFORMS OBSERVED IN MOV MOTOR CURRENT SIGNATURES ARE INDICATIVE OF CYCLIC LOAD VARIATIONS WITHIN THE MOTOR OPERATOR



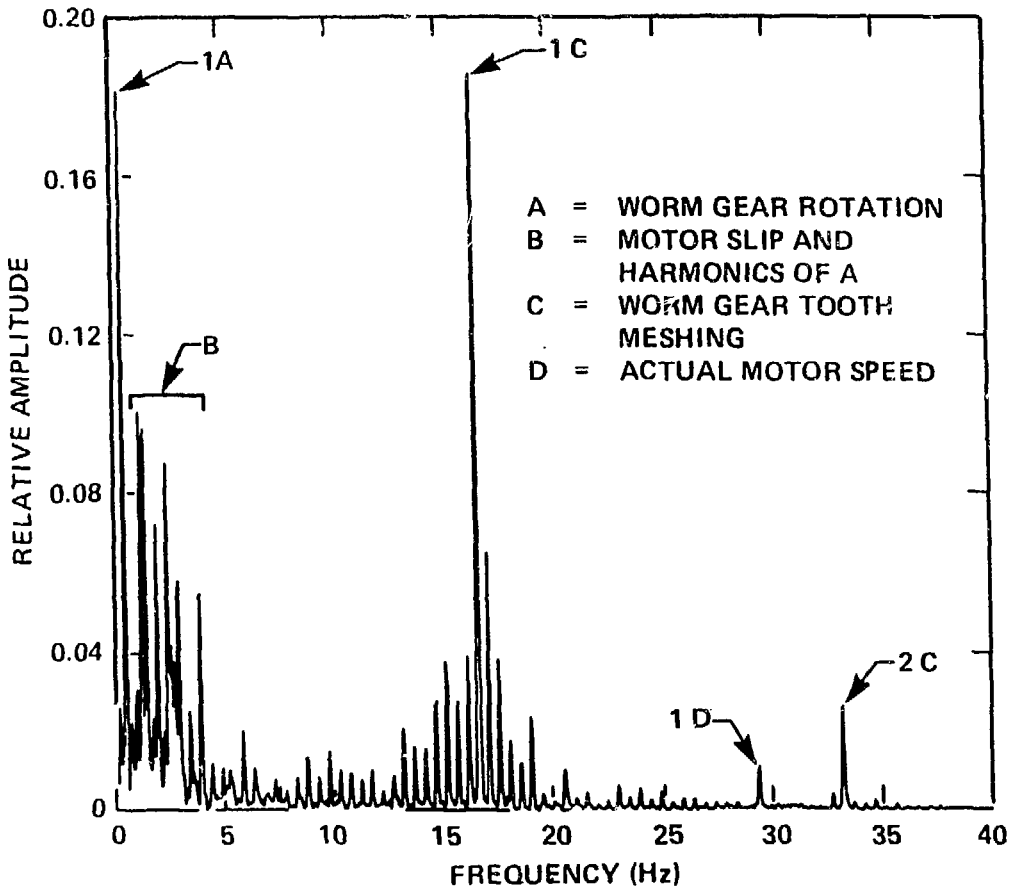
ornl

MOV MOTOR CURRENT SIGNATURES PROVIDE HIGHLY DETAILED INFORMATION SUCH AS WORM GEAR TOOTH MESHING ON A TOOTH–BY–TOOTH BASIS



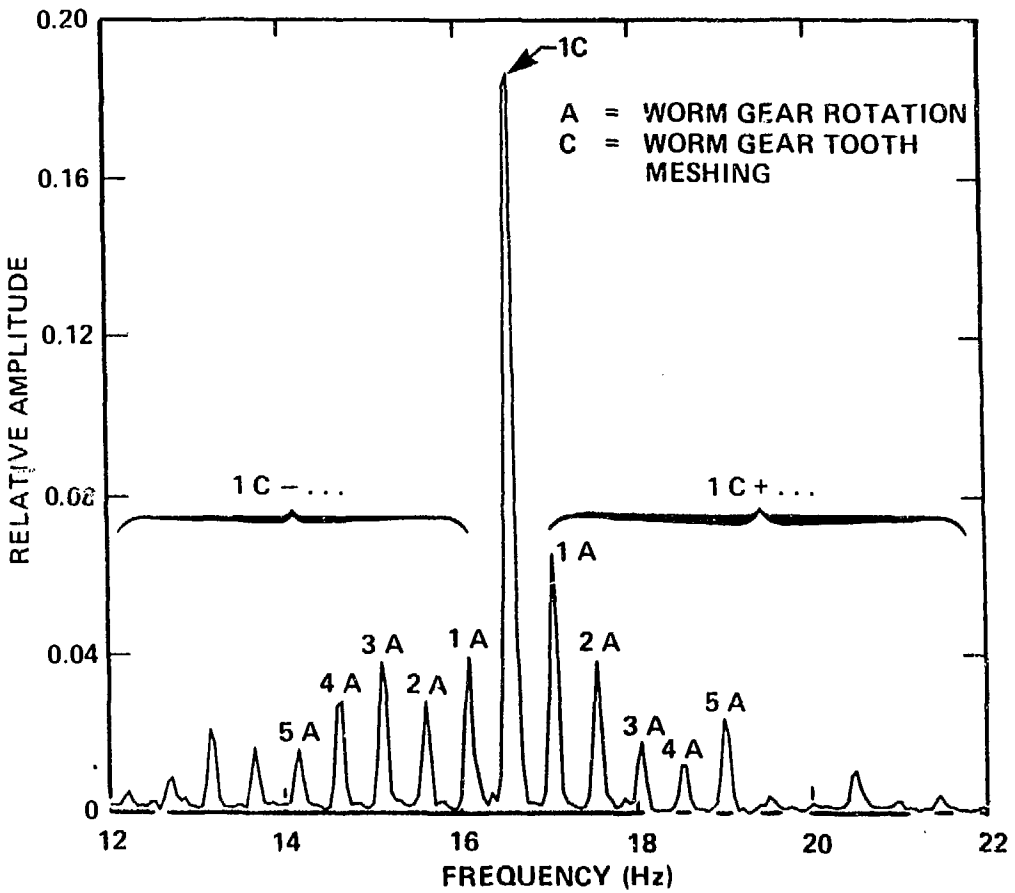
ornl

MOTOR CURRENT FREQUENCY SPECTRUM ANALYSIS PROVIDES A NOVEL MEANS TO REVEAL ADDITIONAL DETAILS OF PERIODIC PHENOMENA OCCURRING WITHIN THE MOTOR AND GEAR TRAIN



ornl

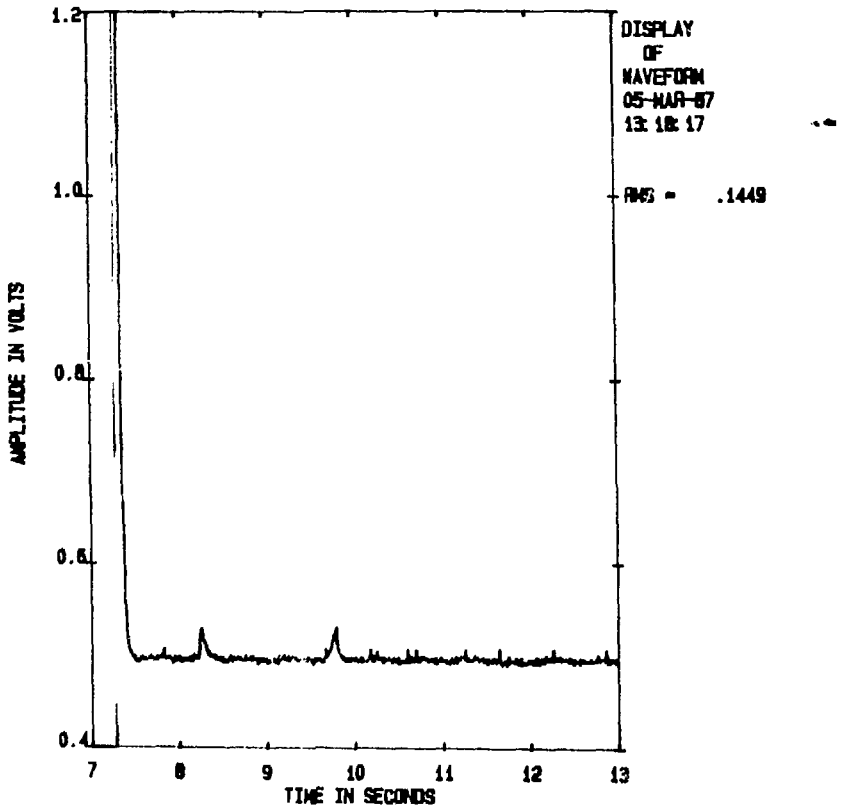
A NARROW–BAND FREQUENCY ANALYSIS OF A MOTOR CURRENT SIGNATURE CAN REVEAL SIDEBAND FREQUENCIES INDICATIVE OF GEAR ECCENTRICITY AND/OR WEAR



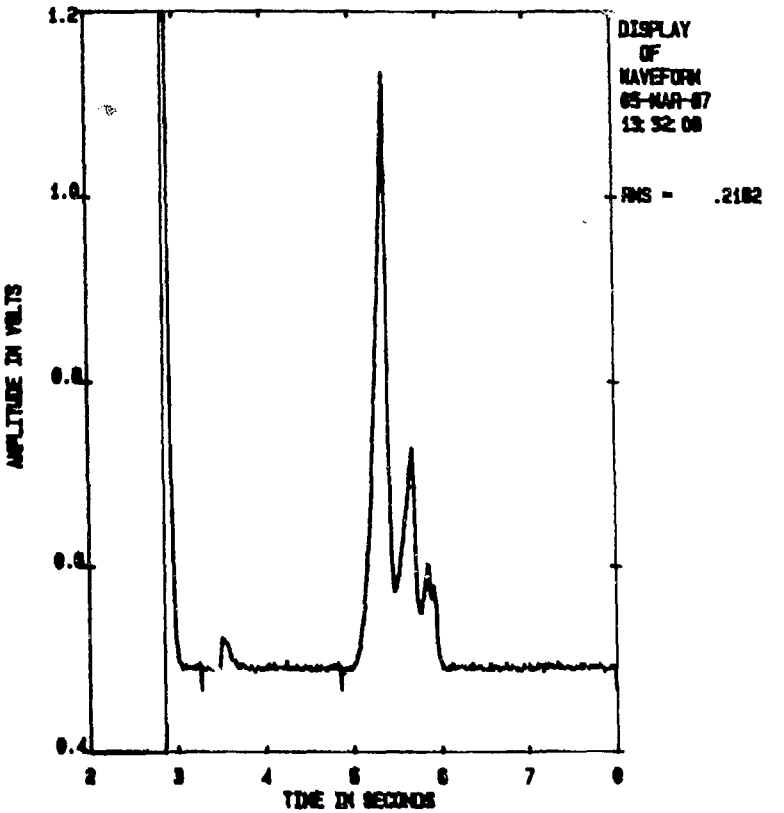
ornl

TWO SIMILAR 16-in NUCLEAR PLANT GATE VALVES EXHIBITED DIFFERENT UNSEATING CHARACTERISTICS

(data acquired at motor control center)



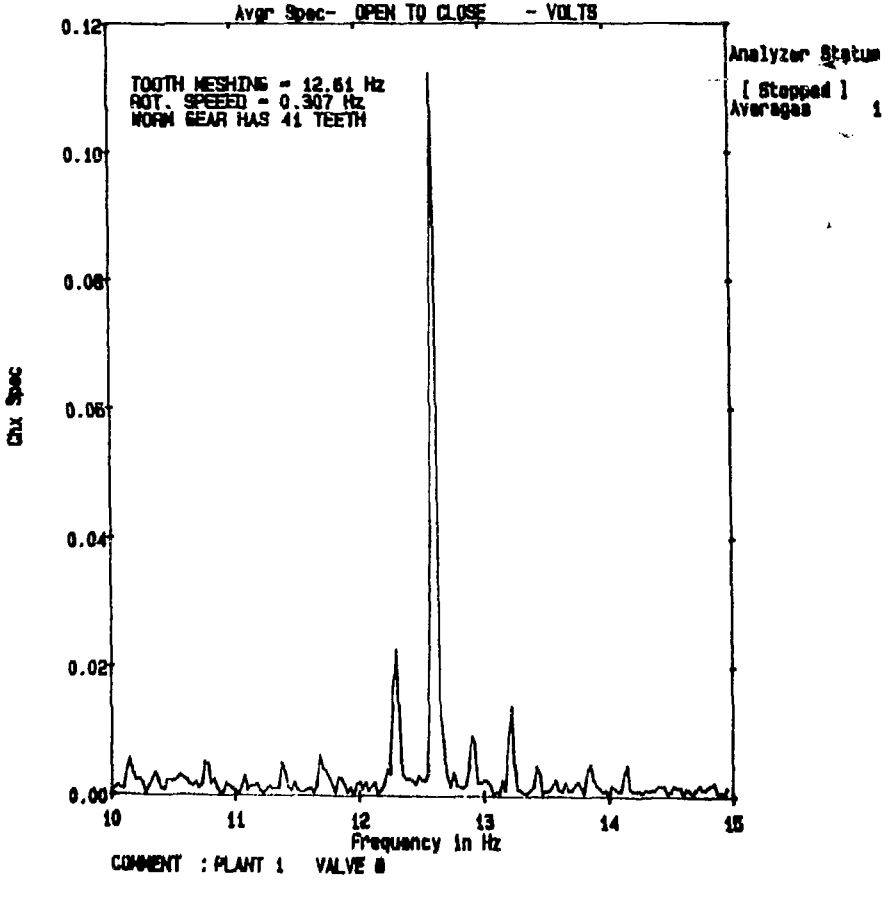
Data Label: PLANT 1 VALVE 6

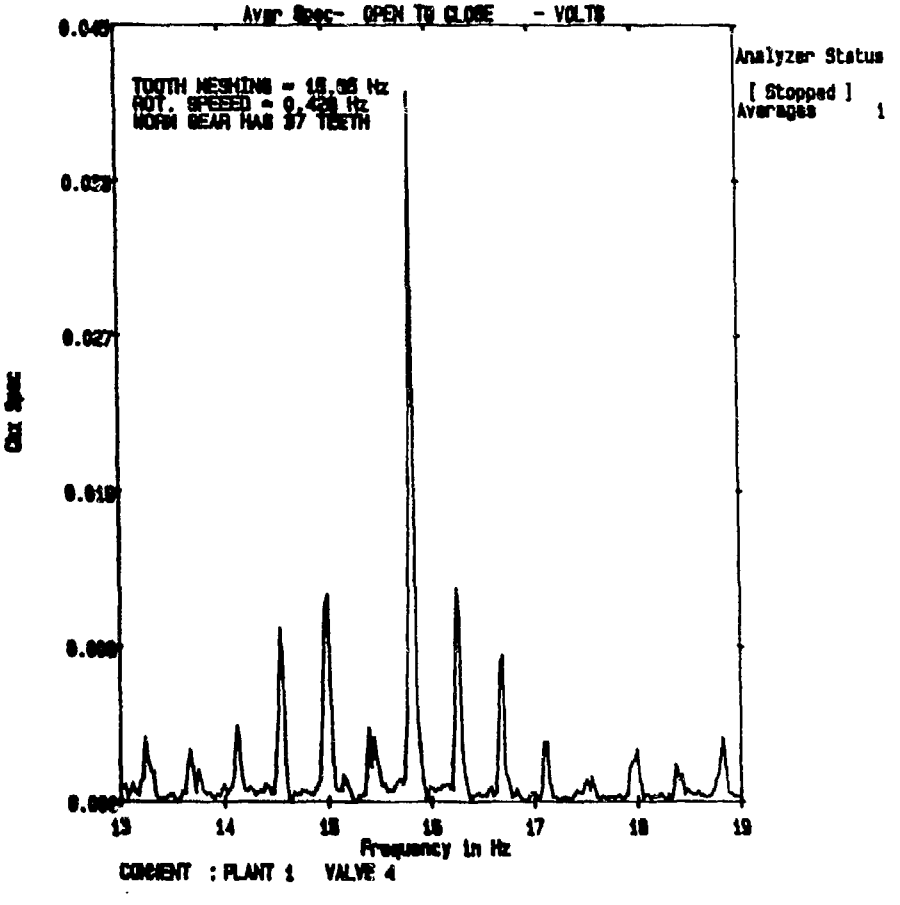


Data Label: PLANT 1 VALVE 7

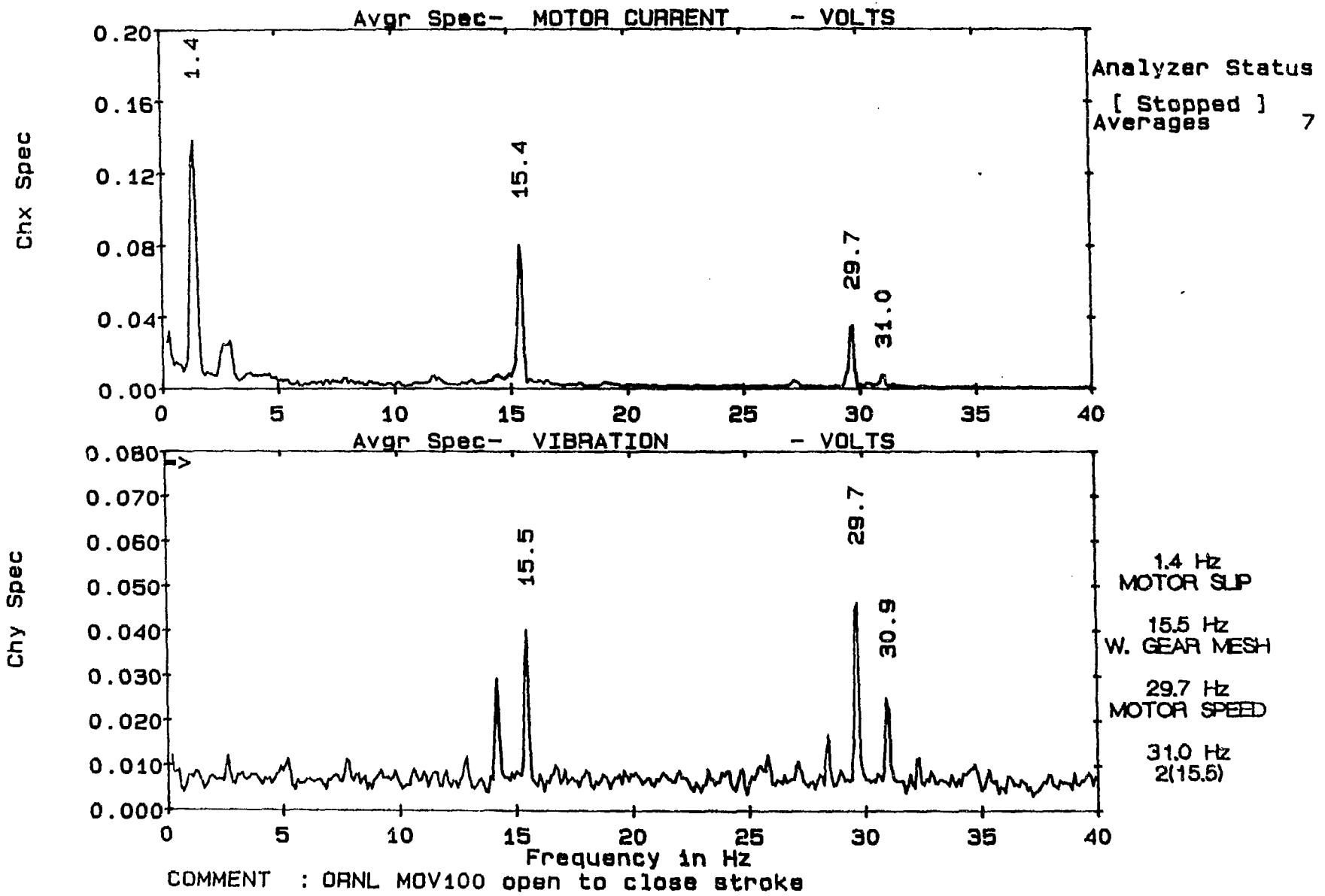
NUCLEAR PLANT MOV TEST DATA HAVE REVEALED ROTATIONAL SIDEBAND AND TOOTH MESHING FREQUENCIES RELATED TO WORM GEAR CONDITION

(data acquired at motor control center)





MOV MOTOR CURRENT AND ACCELEROMETER SPECTRA PRESENT COMPARABLE INFORMATION



MOTOR CURRENT SIGNATURE ANALYSIS OFFERS NEW POSSIBILITIES FOR ASCERTAINING OPERATIONAL READINESS OF MOTOR-OPERATED VALVES

- NONINTRUSIVE MONITORING AT A REMOTE LOCATION (MCC)
- PROVIDES AGING AND DIAGNOSTIC INFORMATION COMPARIBLE TO CONVENTIONAL INSTRUMENTATION (e.g. accelerometers) BUT WITHOUT ATTENDANT DISADVANTAGES
- MEASUREMENTS CAN BE PERFORMED RAPIDLY BY RELATIVELY UNSKILLED PERSONNEL USING PORTABLE, INEXPENSIVE EQUIPMENT
- HIGH SENSITIVITY AND SELECTIVITY TO A VARIETY OF MECHANICAL DISORDERS AFFECTING OPERATIONAL READINESS

MOTOR CURRENT SIGNATURE ANALYSIS HAS POSSIBLE APPLICATIONS IN MANY AREAS ... for example:

- ON-LINE MONITORING OF INDUSTRIAL EQUIPMENT

  Motor-driven compressors and pumps
  Rolling mill stands
  Mixers and crushers
  Fans and blowers

- PRODUCTION LINE TESTING OF MOTOR-DRIVEN APPLIANCES

  Refrigerators and heat pumps
  Washing machines
  Tape/disk players

FOR MORE INFORMATION

Technical Details

H. D. Haynes (615) 574-0375

D. M. Eissenberg (615) 574-0747

R. C. Kryter (615) 574-5561

Commercialization Interests

S. C. Harris (615) 576-8385

MARTIN MARIETTA ENERGY SYSTEMS , INC.