

ATTACHMENT 12

**"Steam Dryer Hammer Test Specification," Test Specification, GE
Report 26A6380, Revision 2, dated April 22, 2005**

DOCUMENT TITLE STEAM DRYER HAMMER TEST SPECIFICATION

LEGEND OR DESCRIPTION OF GROUPS

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MADE BY 9/28/04		APPROVALS		GENERAL ELECTRIC COMPANY	
J LAW		V. RAMANI		175 CURTNER AVENUE	
CHKD BY:		ISSUED		SAN JOSE CALIFORNIA 95125	
NA		RJ AHMANN		CONT ON SHEET 2	



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1.0 TEST OBJECTIVE

The objective of the steam dryer hammer test is to identify the as-built frequencies and mode shapes of several key components of the Quad Cities-2 steam dryer at ambient environment conditions. Different components of the steam dryer have different frequencies and mode shapes associated with them. The areas of interest are the drain channel, the outer hood panel, the inner hood panel, the side panel, the tie bar and the skirt.

The concern is that local natural frequencies may coincide with existing forcing functions to cause resonance conditions. The resonance could cause high stresses to occur in localized areas of the steam dryer. A Finite Element Modal Analysis can calculate the frequency and mode shape of a component, but they are only approximations to the real values due to variations in plate thickness, welding, and other assumptions regarding boundary conditions.

The mode shapes and frequencies determined by the hammer test will be used to validate the finite element modal analysis.

2.0 TEST DESCRIPTION

2.1 Test Description

The hammer test will be performed at a remote facility after the installation of the sensors for in-reactor vibration measurement is completed. Two types of impact tests will be performed on the dryer: a (1) dry hammer test, and a (2) wet hammer test with the steam dryer skirt and drain channel partially submerged in different water levels. Temporary accelerometers will be installed at predetermined locations for this test. Some of the sensors and instrumented hammers that may be submerged during this test shall be waterproofed.

An instrumented hammer will be used to excite the steam dryer. The dryer components will be impacted with the hammer at several pre-determined locations and data will be recorded in the DAS.

After completion of the hammer test, a static load test shall be performed on the front hood on the 270 deg side. Temporary strain gages shall be installed to measure the strain levels when the load is applied. This information shall be used to verify the dryer model.

2.2 Data Acquisition System (DAS)

The DAS shall have the capability of acquiring data from all sensors on a particular component under test simultaneously for online analysis or storing data for offline analysis.



The digital storage system shall be controlled by one PC and shall record signals from all channels simultaneously. The storage system shall comprise of modules converting analog voltage signals into digital signals. Data shall be converted and archived in a non-proprietary format. The system shall have the appropriate transfer rate to support direct data transfer without the need of a data buffer.

The data acquisition and analysis system shall be capable of performing transfer function measurements and spectral analysis. It also shall have the capability of displaying signal time histories for selected channels. The system shall have a minimum frequency bandwidth capability from 0 to 400Hz.

The data analyzer shall be capable of real time spectrum analysis with a minimum of 400 line resolution and at least 60 dB dynamic range. Outputs must be available for hard copy printout.

The tape recorder, if used, shall record all channels simultaneously or in groups. It shall be calibrated and be used as backup storage to the primary PC storage system. The tape recorder shall have a minimum frequency bandwidth range of DC to 400Hz. The input voltage range shall be +/-0.5V to a minimum of 10V programmable. It shall support voice recording for identification.

2.3 Communication Link

A voice communication link between the impact hammer test personnel and the DAS engineer will be required to perform the test if the DAS location is not within audible distance from the dryer.

3.0 SITE INSTALLATION

3.1 Equipment Installation

The DAS test equipment area should be set up as close as possible near the steam dryer test area to minimize the cable length. The DAS will require a 110V, 60HZ, 30amp power source to power the test instruments.

3.2 Sensor Installation

Temporary accelerometers and strain gages will be installed on the dryer for the hammer test. Location of the accelerometers will be determined based on finite element analysis of the steam dryer.

Sensor cables will be clearly labeled at each end, and connected to the corresponding sensor signal conditioning unit located in the DAS area. Continuity checks will be performed on all signal cables to verify proper sensor connections to the DAS. The DAS will obtain data from all sensors and the instrumented hammer simultaneously.



3.2.1 Accelerometer Installation

Piezoelectric type accelerometers model PCB 333A32, 333B30, and 333B32 or equivalent will be used. The accelerometers will be attached to the steam dryer using a suitable adhesive. Details of the accelerometer installation are provided in Appendix B

3.2.2 Strain Gage Installation

Temporary bondable foil strain gages shall be installed on predetermined locations after surface preparation. The strain gages shall be installed using Vishay Micro-Measurement M-bond 200 adhesive or equivalent.

3.2.3 Instrumented Hammer

Three PCB hammer models, 086C05, 086C20, and 086C50 or equivalent, will be used for the tests. The hammers used for the wet hammer test will need to be waterproofed. Steel tips shall not be used to impact the dryer.

3.3 Impact Hit Location Identification

An analysis on the finite element model of the steam dryer shall be performed to determine the impact hit locations. The impact locations will be clearly marked. Records of the impact locations will be kept in a test log. An example is shown in Appendix A.

4.0 DATA ACQUISITION SYSTEM SETUP

4.1 Data Acquisition System

The DAS consists of chassis that will acquire the data, and a DAS PC Workstation (DASPC) that will control the acquisition and storage of the data. The DASPC will also house the analysis software. A list of the equipment used in this test program will be included in the test design record file. All data acquisition equipment/test instruments used for this test will be in calibration.

4.1.1 Analog to Digital Converter Chassis

The SCADAS-316 chassis will be used to convert analog signals from the sensors and signal conditioning equipment into digital signals to be stored in the DASPC. The analog to digital (A/D) converters shall be properly calibrated prior to use.

4.1.2 Channel Assignments

During data acquisition setup, the sensor cables from the signal conditioning system will be connected to the assigned data (A/D) acquisition channel. The signal assignment shall be detailed in a chart, similar to that shown in Table 1. The test engineer shall check the sensor signals to insure channel assignments are properly connected and match the A/D Channel Assignment.



4.1.3 Spectrum Analysis

Data analysis will be performed on the DASPC. The software will be set up for spectrum analysis as data is obtained and recorded.

4.2 Optional Backup Data Recording

If used, a tape recorder, shall record data in parallel with the DASPC. Signals from the signal conditioning system shall be split and routed to the tape recorder. The test engineer shall check the sensor signals to insure channel assignments are properly connected and match the Tape Channel Assignment chart which shall be used to document the channel assignment setup. A sample of a Tape Channel Assignment chart is show on Table 2.

4.2.1 Calibration Signal

A calibration signal of 0.707Vrms and 100Hz sinusoidal signal will be recorded at the beginning or end of each tape. After recording the calibration signal on all active recording channels, the test engineer will play back the calibration signals to verify tape recorder operability.

4.3 Communication System

A voice communication link between the impact hammer test personnel and the DAS engineer will be required to perform the test if the DAS location is not within audible distance from the dryer.

4.4 Test Log

A separate written test log shall be constructed and used to track the hammer hits and saved data files on the DASPC. This document will serve as a cross-reference between the test and the data filename.

5.0 TEST PROCEDURES

5.1 Activate Equipment

Turn on the signal conditioning system, the DASPC and other test instruments.

5.2 Accelerometer, Strain Gage and Hammer Initial Setup

The recommended initial gains for the accelerometers, strain gages and hammer force transducer outputs are 100mV/g, 10mV/microstrain, and 10mV/lbf, respectively. The sensitivities can be increased or decreased to obtain desired output during the test. It is recommended that the signal output not exceed 5V maximum during trial impact of the dryer component. **Exercise caution not to hit any of the installed sensors, sensor cables or conduits.**

5.3 DAS Setup

The DAS setup includes ensuring that the DASPC, the A/D Converter Chassis, and the tape recorder (if used) are properly configured.



5.3.1 DASPC

Start up the DASPC workstation with the appropriate data acquisition software. Start up the spectrum analysis software on the workstation for real-time analysis and to monitor the quality of the data.

5.3.2 A/D Converter Chassis

Power up the A/D Converter Chassis and ensure that the A/D Converter Chassis is communicating properly with the DASPC.

5.3.3 Tape Recorder

If used, use new tape, rewind data tape to beginning of tape and reset tape recorder counter to 0000.

5.3.4 Calibration Signal

Record a calibration signal (0.707 Vrms @100 Hz) at the beginning of each data tape. Use the tape speed corresponding to a frequency bandwidth from DC to 625 Hz and document in tape log.

5.3.5 Test ID Recording on Voice Channel for Calibration Signal

If used, record the following on the voice channel when recording the calibration signal segment on each tape:

1. Title of test – calibration signal
2. Tape number
3. Date and time of recording
4. Tape speed
5. Tape start and stop count
6. Tape recorder input range (volts) and zero offset (%)
7. Calibration signal amplitude and frequency

5.4 Communication

Establish voice communication between DAS and test area personnel if needed. Verify that communications are functional prior to the test.

5.5 Data Acquisition Logger Set up for Testing

Record the following information at the beginning of each work shift during the following series of tests.

DASPC

1. Title of test
2. Sensor and impact hammer location
3. Filename of saved data
4. Date and time of data acquisition
5. Signal conditioner gain settings



An example is shown in Table 5.

If a tape recorder is used, record the following information in addition to the above:

Tape Recorder

1. Tape number and test point
2. Date and time of recording
3. Tape speed
4. Tape count
5. Tape recorder channel assignments
6. Tape recorder input range (volts) and zero offset (%)
7. Calibration signal amplitude and frequency (for cal signal segment of tape)

5.6 Hammer Testing

The dryer will need to be supported at 4 points, simulating support conditions inside the reactor. A temporary pool shall be built to simulate the RPV wall. The distance between the skirt and the simulated RPV wall shall be the same as inside the reactor.

Tap (hit) the steam dryer (or components) at the predetermined locations with the instrumented hammer. A minimum of three good "single spike" hits, as indicated on the DASPC spectrum analyzer, shall be made and recorded for each impact location. Signals from the hammer and all sensors shall be recorded on the DASPC. Test signals shall be monitored by the vibration test engineer on the DASPC spectrum analyzer. Sensor gains shall be set up such that the signal response is optimized. **Exercise caution not to hit any of the installed sensors, sensor cables or conduits.**

5.7 Test Sequence

There will be 4 different test conditions for the steam dryer hammer test followed by the static load test. All tests shall be performed with the dryer supported at four points to simulate reactor conditions and after completion of the sensor installation for in-reactor vibration measurement.

5.7.1 Dry Hammer Test

This test phase is done with no water in the tank. Temporary sensors shall be placed and connected at the first set of locations. The dryer will be impacted with calibrated hammers and data will be collected. The sensors will then be relocated to the second set of locations, the dryer impacted and data collected. This process will continue until all selected dryer locations have been tested.

5.7.2 Wet Hammer Test – High Water Level (HWL)

With the dryer skirt submerged up to the high water level for reactor conditions, repeat the sensor placement, hammer impact and data collection for all locations as detailed in 5.7.1. Make note of those sensor locations whose responses change with the addition of the water.



5.7.3 Wet Hammer Test – Normal Water Level (NWL)

Drain water from the tank until the water reaches the normal water level for reactor conditions. Repeat the sensor placement, hammer impact and data collection for those points that indicated a change from the dry test to high water level test (section 5.7.2) and note those sensor locations whose responses change with the change in water level.

5.7.4 Wet Hammer Test – Low Water Level (LWL)

Drain water from the tank until the water reaches the low water level for reactor conditions. Repeat the sensor placement, hammer impact and data collection for those points that indicated a change from the high water level test to the normal water level test (section 5.7.3).

5.7.5 Static Load Test

This test shall be performed before or after the hammer test. Temporary strain gages shall be installed on predetermined locations on the lightly instrumented side of the dryer front hood plate. A static load of 1000 lbs shall be applied at the mid section of the left side front hood plate opposite to steam nozzle D. To create uniform pressure, the load shall be applied to a 1 inch thick soft (40-durometer) pad by means of a 0.75 inch thick, 14 inch diameter steel plate. The load shall be applied normal to the surface. The static strain responses and the load cell output shall be recorded when applying the incremental load and while decreasing the load.

6.0 POST-TEST PROCEDURE

6.1 Test Equipment Removal

After the steam dryer hammer testing is complete, all temporary sensors, cables and test equipment shall be removed from the steam dryer test area and the DAS area.

6.1.1 Accelerometer Removal

Accelerometer removal is detailed in Appendix C.

6.2 Shipment of DAS Equipment

DAS equipment, including tape recorder (if used), signal conditioning system and DASPC, will be shipped to site or hand carried to site by GE test Engineers or by a GE Company designate.

7.0 QUALITY ASSURANCE

7.1 Test Instruments

During this test program set up, test performance and data acquisition, the following shall be performed:



1. Use calibrated test instruments.
2. Record in test log the make, model, serial number and calibration dates on all test instruments used in this test program.
3. Initially and periodically, check that all vibration sensors are functional prior to installation, testing and data acquisition.
4. Initially and periodically, verify gain settings on data acquisition equipment.
5. Record all test parameters and instrument setups in the applicable logs.

7.2 Design Record File

Retain data records and documentation in GENE Design Record File:

eDRF 0000-0030-1241



APPENDIX A – TABLES

Table 1

A/D CHANNEL ASSIGNMENT

A/D CHASSIS:				A/D CHASSIS:			
A/D CHANNEL	SENSOR ID	A/D CHANNEL	SENSOR ID	A/D CHANNEL	SENSOR ID	A/D CHANNEL	SENSOR ID
1A		9A		1A		9A	
1B		9B		1B		9B	
1C		9C		1C		9C	
1D		9D		1D		9D	
2A		10A		2A		10A	
2B		10B		2B		10B	
2C		10C		2C		10C	
2D		10D		2D		10D	
3A		11A		3A		11A	
3B		11B		3B		11B	
3C		11C		3C		11C	
3D		11D		3D		11D	
4A		12A		4A		12A	
4B		12B		4B		12B	
4C		12C		4C		12C	
4D		12D		4D		12D	
5A		13A		5A		13A	
5B		13B		5B		13B	
5C		13C		5C		13C	
5D		13D		5D		13D	
6A		14A		6A		14A	
6B		14B		6B		14B	
6C		14C		6C		14C	
6D		14D		6D		14D	
7A		15A		7A		15A	
7B		15B		7B		15B	
7C		15C		7C		15C	
7D		15D		7D		15D	
8A		16A		8A		16A	
8B		16B		8B		16B	
8C		16C		8C		16C	
8D		16D		8D		16D	

Data Collected By: _____ Signature: _____

Verified By: _____ Signature: _____

Date Performed: _____

Test Equip., Serial No. & Calibration Due Date: _____



Table 2

TAPE RECORDER

CHANNEL	SENSOR ID	CHANNEL	SENSOR ID	CHANNEL	SENSOR ID
1		33		65	
2		34		66	
3		35		67	
4		36		68	
5		37		69	
6		38		70	
7		39		71	
8		40		72	
9		41		73	
10		42		74	
11		43		75	
12		44		76	
13		45		77	
14		46		78	
15		47		79	
16		48		80	
17		49		81	
18		50		82	
19		51		83	
20		52		84	
21		53		85	
22		54		86	
23		55		87	
24		56		88	
25		57		89	
26		58		90	
27		59		91	
28		60		92	
29		61		93	
30		62		94	
31		63		95	
32		64		96	

Data Collected By: _____

Signature: _____

Verified By: _____

Signature: _____

Date Performed: _____

Test Equip., Serial No. & Calibration Due Date: _____



APPENDIX B – ACCELEROMETER INSTALLATION

B1.0 Installation with Micro-Measurement Adhesive Bonding

B.1.1 Materials Required:

1. Accelerometer mounting bases
2. Accelerometer types PCB models 333A32, 333B30, 333B32
3. Acetone
4. Silicon carbide Paper – 400 grit
5. GSP-1 Gauze sponges
6. CSP-1 Cotton Applicator
7. Micro-Measurement M-Prep Conditioner A
8. Micro-Measurement M-Prep Neutralizer 5A
9. Micro-Measurement M-Bond 200 Adhesive
10. Micro-Measurement M-Bond 200 Catalyst

B.1.2 Surface Preparation

1. Mark all locations where the accelerometers are to be installed with a nuclear-quality marking pen. (To be provided by GE)
2. Clean the area where the accelerometer is to be installed with acetone
3. Wet the surface area with M-Prep Conditioner A and abrade with 400 grit silicon carbide paper
4. Wipe the surface dry with gauze sponge
5. Repeat abrading and wiping process once more
6. Apply M-Prep Neutralizer 5A to the surface and scrub with cotton applicator. With a single slow motion of the gauze sponge, carefully dry this surface

B.1.3 Accelerometer Mounting Base Installation

1. Attach the accelerometer to the smooth side of the accelerometer mounting base
2. Clean the mounting base surface with acetone and wipe dry with gauze sponge
3. Apply a thin coat of M-Bond 200 Catalyst and let it dry for at least one minute
4. Apply a thin coat of M-Bond 200 Adhesive on the mounting surface and firmly press the accelerometer mounting base onto the surface. Keep thumb pressure for at least one minute.
5. Allow 5 minutes for mounting base to solidly bond in place



APPENDIX C – ADHESIVE REMOVAL

C.1 M-Bond 200

C1.1 Materials Required

1. Silicon Carbide paper – 400 grit
2. Reagent Grade acetone
3. Ultra-violet (black) light source
4. Scraping Device

C1.2 Procedure

1. Gently tap the base of the accelerometer sideways to shear sensor away from the dryer.
2. Remove the foil strain gages by scraping with a blade.
3. Remove any remaining bonding adhesive left on the stainless steel surface by gently scraping the surface and abrading with 400 grit silicon carbide paper
4. Clean the surface with reagent grade acetone. Clean repeatedly until no visual signs of the adhesive appear on the stainless steel when illuminated with an ultra-violet (black) light.

The M-Bond 200 bonding material should be removed from the steam dryer surface no later than 7 days from the application.



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APPENDIX D – MATERIALS SAFETY DATA SHEETS



MATERIAL SAFETY DATA SHEET

SECTION 1: CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT: M-Bond 200 Adhesive

April 13, 2004

Vishay Micro-Measurements
Post Office Box 27777
Raleigh, NC 27611

MSDS # MGM0070

919-365-3800

CHEMTREC 1-800-424-9300 (U.S.)
703-527-3887 (Outside U.S.)

NOTE: CHEMTREC numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

SECTION 2: HAZARDOUS INGREDIENTS / IDENTITY INFORMATION

NOTE: This material is purchased from a number of suppliers and distributed by Vishay Micro-Measurements. To ensure that you have the appropriate information, cross-reference the following data with the manufacturer's label on the product you purchased.

CAS NUMBER	CHEMICAL IDENTITY	%
Methyl Cyanoacrylate Adhesive MC-100 (Chemence, Inc.)		
137-05-3	Methyl 2-Cyanoacrylate	90-95
9011-14-7	Poly Methyl Methacrylate	5-10
123-31-9	Hydroquinone	0.1-0.5
Ethyl Cyanoacrylate Adhesive EC-100E (Chemence, Inc.)		
7085-85-0	Ethyl Cyanoacrylate	95-100
9011-14-7	Poly Methyl Methacrylate	3-5
123-31-9	Hydroquinone	0.1-0.5
Cyberbond APOLLO 2010 (Cyberbond, L.L.C.)		
7085-85-0	Ethyl 2 Cyanoacrylate	80-90
9011-14-7	Poly Methyl Methacrylate	10-20

SECTION 3: HEALTH HAZARD DATA**Routes of Entry:**

Inhalation: YES Skin: YES Ingestion: Accidental

Health Hazards (Acute and Chronic): Bonds skin rapidly and strongly.

Carcinogenicity:	NTP:	Not listed
	IARC Monographs:	Not listed
	OSHA Regulated:	Not listed

Signs and Symptoms of Exposure:

INHALATION: Vapor is irritating to nose and bronchial passages. Prolonged and repeated over-exposure to vapors may produce allergic reactions with asthma-like symptoms in sensitive individuals.

EYE CONTACT: Cyanoacrylates may bond eyelid to eyelid and/or eye.

SKIN CONTACT: Cyanoacrylates bond skin rapidly and strongly. A large drop may cause burn upon solidification.

INGESTION: It is almost impossible to swallow cyanoacrylates. The adhesive solidifies and adheres in mouth. Lips may become stuck together.

Conditions Generally Aggravated by Exposure: None known.

SECTION 4: EMERGENCY AND FIRST AID PROCEDURES

Information for first aid and casualty on treatment for adhesion of human skin to itself if caused by cyanoacrylate adhesives.

Cyanoacrylate adhesive is a very fast setting and strong adhesive. It bonds human tissue including skin in seconds. Experience has shown that accidents due to cyanoacrylates are handled best by passive, non-surgical first aid. Treatment of specific types of accidents are given below.

SKIN CONTACT: Remove excess adhesive. Soak in warm, soapy water. The adhesive will come loose from the skin in several hours. Dried adhesive does not present a health hazard even when bonded to the skin. Avoid contact with clothes, fabric, rags or tissue. Contact with these materials may cause polymerization. The polymerization of large amounts of adhesive will generate heat causing smoke, skin burns, and strong, irritating vapors. Wear rubber or polyethylene gloves and an apron when handling large amounts of adhesive.

SKIN ADHESION: First, immerse the bonded surface in warm soapy water. Peel or roll the surfaces apart with the aid of a blunt edge, e.g. a spatula or a teaspoon handle; then remove adhesive from the skin with soap and water. Do not try to pull surfaces apart with a direct opposing action.

EYELID TO EYELID OR EYEBALL ADHESION: In the event that eyelids are stuck together or bonded to the eyeball, wash thoroughly with warm water and apply a gauze patch. The eye will open without further action, typically in 1 - 4 days. There will be no residual damage. Do not try to open the eyes by manipulation.

ADHESIVE ON THE EYEBALL: Cyanoacrylate introduced into the eyes will attach itself to the eye protein and will disassociate from it over an indeterminable period, generally covering several hours. This will cause periods of weeping until clearance is achieved. During the period of contamination, double vision may be experienced together with a lachrymatory effect, and it is important to understand the cause and realize that disassociation will normally occur within a matter of hours, even with gross contamination.

MOUTH: If lips are accidentally stuck together, apply lots of warm water to the lips and encourage maximum wetting and pressure from saliva inside the mouth. Peel or roll lips apart. Do not try to pull the lips with direct opposing action.

It is almost impossible to swallow cyanoacrylate. The adhesive solidifies and adheres in the mouth. Saliva will lift the adhesive in 1/2 to 2 days. In case a lump forms in the mouth, position the patient to prevent ingestion of the lump when it detaches.

INGESTION: Saliva should lift the adhesive in 12 to 48 hours. Do not force removal. Do not swallow the adhesive when it loosens.

BURNS: Cyanoacrylates give off heat on solidification. In rare cases a large drop will increase in temperature enough to cause a burn.

Burns should be treated normally after the lump of cyanoacrylate is released from the tissue as described above.

SURGERY: It should never be necessary to use such a drastic method to separate accidentally bonded skin.

INHALATION: Move to fresh air. If symptoms persist, call a physician.

SECTION 5: FIRE AND EXPLOSION HAZARD DATA

Flash Point (Method Used): 150°F - 200°F Tag Closed Cup

Flammable limits: LEL: Not determined UEL: Not determined

Extinguishing Media: Carbon dioxide, foam, dry chemical.

Special Firefighting Procedures: Firefighters should wear proper protective clothing and self-contained breathing apparatus.

Unusual Fire and Explosion Hazards: Vapors exceeding the flash point will ignite when exposed to flame.

SECTION 6: ACCIDENTAL RELEASE MEASURES

Steps to be taken if material is released or spilled: Flood with water to polymerize cyanoacrylate adhesive and to control product vapors. Soak up with an inert absorbent or scrape up cured product.

SECTION 7: EXPOSURE CONTROLS -- PERSONAL PROTECTION

Respiratory Protection: Use fresh air breathing apparatus or solvent filter mask when exposed to large quantities.

Ventilation: Positive down-draft exhaust ventilation should be provided to maintain vapor concentration below TLV.

Local Exhaust: Keep below TLV.

Mechanical: Keep below TLV.

Special: N/A

Other: N/A

Protective Gloves: Polyethylene gloves recommended. Do not use cotton gloves.

Eye Protection: Safety glasses or goggles.

Other Protective Clothing or Equipment: Polyethylene apron recommended.

Work / Hygienic Practices: Wash hands thoroughly after using product.

SECTION 8: HANDLING AND STORAGE

Precautions to be taken in handling and storing: Store at or below 75°F to maximize shelf life. Avoid contact with skin and eyes. Avoid breathing vapors.

Other Precautions: None.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Boiling Point:	>150°F (66°C)
Vapor Pressure (mmHg):	<0.2 @ 75°F (24°C)
Vapor Density (Air = 1):	>1
Specific Gravity (H₂O = 1):	1.09
Melting Point:	Not determined
Evaporation Rate (BuAc = 1):	Not determined
Volatile Organic Compounds:	≈ 1000 g/liter

Solubility in Water: Insoluble; polymerized by water.

Appearance and Odor: Clear liquid with sharp, pungent odor.

SECTION 10: STABILITY AND REACTIVITY DATA

Stability: Stable.

Conditions to Avoid: High temperatures.

Incompatibility (Materials to Avoid): Water, alcohols, amines, alkalies, peroxides, cotton and wool.

Hazardous Decomposition or By-products: None known.

Hazardous Polymerization: Will not occur.

SECTION 11: TOXICOLOGICAL INFORMATION**Methyl Cyanoacrylate**

OSHA PEL:	Not Established
ACGIH TLV:	2 ppm TWA Estimated
OTHER:	None

Ethyl Cyanoacrylate

OSHA PEL:	Not known
ACGIH TLV:	2 ppm TWA
ACGIH STEL:	4 ppm TWA
OTHER:	None

Poly Methyl Methacrylate

OSHA PEL:	None
ACGIH TLV:	None
OTHER:	None

Hydroquinone

OSHA PEL:	2 mg/M ³ TWA
ACGIH TLV:	2 mg/M ³ TWA
OTHER:	4 mg/m ³ STEL

SECTION 12: DISPOSAL CONSIDERATIONS

Waste Disposal Method: Dispose of in accordance with local, state, and federal regulations.

SECTION 13: TRANSPORTATION INFORMATION**SHIPPING NAME****CLASS****UN NUMBER**

Not regulated.

SECTION 14: REGULATORY INFORMATION**SECTION 313 SUPPLIER NOTIFICATION:**

This product contains a toxic chemical or chemicals (as listed below) subject to the reporting requirements of Section 313 Title III of the Superfund Amendment and Reauthorization Act of 1986 and 40 CFR Part 372.

CAS NUMBER**CHEMICAL NAME****% BY WEIGHT**

123-31-9

Hydroquinone

0.1-0.5

TSCA NOTIFICATION:

All components of this product are listed in the Toxic Substance Control Act Chemical Substance Inventory (TSCA).

SECTION 15: OTHER INFORMATION

To the best of our knowledge, the information provided above meets the requirements of the United States Occupational Safety and Health Act and regulations established under 29 CFR 1910.1200 (g)(2)(c)(1)-(4) for a mixture of hazardous chemicals which has not been tested as a whole. The data provided on this Material Safety Data Sheet is from manufacturers of the original components. Vishay Micro-Measurements specifically disclaims any and all form of liability and/or responsibility for the application of this product.



MATERIAL SAFETY DATA SHEET

SECTION 1: CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT: M-Bond 200 Catalyst C

October 10, 2002

Vishay Micro-Measurements
Post Office Box 27777
Raleigh, NC 27611

MSDS # MGM059F

919-365-3800

CHEMTREC 1-800-424-9300 (U.S.)
703-527-3887 (Outside U.S.)

NOTE: CHEMTREC numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

SECTION 2: HAZARDOUS INGREDIENTS / IDENTITY INFORMATION

CAS NUMBER	CHEMICAL IDENTITY	%
67-63-0	2-Propanol	98.0
120-07-0	n-Phenyldiethanolamine	2.0

SECTION 3: HEALTH HAZARD DATA

Routes of Entry:

Inhalation: YES **Skin:** YES **Ingestion:** Accidental

Health Hazards (Acute and Chronic): Skin contact over-exposure may cause dermatitis.

Carcinogenicity:	NTP:	Not listed
	IARC Monographs:	Not listed
	OSHA Regulated:	Not listed

Signs and Symptoms of Exposure:

INHALATION: May cause irritation of nose and throat, headache, nausea, vomiting, dizziness, drowsiness, irritation of upper respiratory tract, unconsciousness.

EYE CONTACT: May cause irritation. May cause temporary corneal damage.

SKIN CONTACT: May cause irritation. Prolonged contact may cause dermatitis.

INGESTION: May cause headache, nausea, vomiting, dizziness, gastrointestinal irritation.

Conditions Generally Aggravated by Exposure: None known.

SECTION 4: EMERGENCY AND FIRST AID PROCEDURES
--

INHALATION: If inhaled, remove victim to fresh air and provide oxygen if breathing is difficult. If not breathing, give artificial respiration. Contact a physician.

EYE CONTACT: In case of eye contact, immediately flush with plenty of water for at least fifteen minutes. Contact a physician.

SKIN CONTACT: Wash affected area immediately with large amounts of soap and water. Remove and wash contaminated clothing before reuse. Contact a physician if irritation occurs.

INGESTION: CALL A PHYSICIAN. If swallowed, if conscious, give large amounts of water. Induce vomiting.

SECTION 5: FIRE AND EXPLOSION HAZARD DATA
--

Flash Point (Method Used): 53°F (11°C) Closed Cup

Flammable limits: LEL: 2.0 UEL: 12.0

Extinguishing Media: Alcohol foam, dry chemical, carbon dioxide.

Special Firefighting Procedures: Firefighters should wear proper protective clothing and self-contained breathing apparatus.

Unusual Fire and Explosion Hazards: Closed containers may explode if exposed to high heat.

SECTION 6: ACCIDENTAL RELEASE MEASURES

Steps to be taken if material is released or spilled: Wear suitable protective clothing. Shut off ignition sources; no flares, smoking, or flames in area. Stop leak if you can do so without risk. Use water spray to reduce vapors. Take up with sand or other non-combustible absorbent material and place into container for later disposal. Flush area with water.

SECTION 7: EXPOSURE CONTROLS -- PERSONAL PROTECTION

Respiratory Protection: Respiratory protection required if airborne concentration exceeds TLV. At concentrations up to 1000 ppm, a chemical cartridge respirator with organic vapor cartridge is recommended. Above this level, a self-contained breathing apparatus is recommended.

Ventilation: Use general or local exhaust ventilation to meet TLV requirements.

Local Exhaust: Keep below TLV

Mechanical: Keep below TLV

Special: N/A

Other: N/A

Protective Gloves: Butyl rubber gloves are recommended.

Eye Protection: Safety goggles are recommended.

Other Protective Clothing or Equipment: Protective apron is recommended.

Work / Hygienic Practices: Wash thoroughly after using.

SECTION 8: HANDLING AND STORAGE

Precautions to be taken in handling and storing: Keep container tightly closed. Store in a cool, dry, well-ventilated, flammable liquid storage area.

Other Precautions: Bond and ground containers when transferring liquid.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Boiling Point: 181°F (83°C)
Vapor Pressure (mmHg): 33 @ 68°F (20°C)
Vapor Density (Air = 1): 2.1
Specific Gravity (H₂O = 1): 0.78
Melting Point: -128°F (-89°C)
Evaporation Rate (BuAc = 1): 2.83
Volatile Organic Compounds: 98%
Solubility in Water: 98%

Appearance and Odor: Blue liquid; alcohol odor.

SECTION 10: STABILITY AND REACTIVITY DATA

Stability: Stable.

Conditions to Avoid: Heat, flame, other sources of ignition.

Incompatibility (Materials to Avoid): Strong oxidizing agents, strong acids, nitric acid, sulfuric acid, halogens, active halogen compounds.

Hazardous Decomposition or By-products: Carbon monoxide, carbon dioxide.

Hazardous Polymerization: Will not occur.

SECTION 11: TOXICOLOGICAL INFORMATION**2-Propanol**

OSHA PEL: 400 ppm
ACGIH TLV: 400 ppm
OTHER: LD₅₀ ORAL (RAT) 5840 mg/kg
LD₅₀ INTRAPERITONEAL (MOUSE) 933 mg/kg
LD₅₀ ORAL (DOG) 6150 mg/kg
LD₅₀ SKIN (RABBIT) 12.8 g/kg

n-Phenyldiethanolamine

OSHA PEL: Not established
ACGIH TLV: Not established
OTHER: Not available

SECTION 12: DISPOSAL CONSIDERATIONS

Waste Disposal Method: Dispose of in accordance with local, state, and federal environmental regulations.

SECTION 13: TRANSPORTATION INFORMATION

SHIPPING NAME	CLASS	PACKING GROUP	UN NUMBER
Isopropanol (Isopropyl Alcohol) Flammable Liquid	3	II	1219

SECTION 14: REGULATORY INFORMATION**SECTION 313 SUPPLIER NOTIFICATION:**

This product contains a toxic chemical or chemicals (as listed below) subject to the reporting requirements of Section 313 Title III of the Superfund Amendment and Reauthorization Act of 1986 and 40 CFR Part 372.

CAS NUMBER	CHEMICAL NAME	% BY WEIGHT
67-63-0	2-Propanol	98.0

TSCA NOTIFICATION:

All components of this product are listed in the Toxic Substance Control Act Chemical Substance Inventory (TSCA).

SECTION 15: OTHER INFORMATION

To the best of our knowledge, the information provided above meets the requirements of the United States Occupational Safety and Health Act and regulations established under 29 CFR 1910.1200 (g)(2)(c)(1)-(4) for a mixture of hazardous chemicals which has not been tested as a whole. The data provided on this Material Safety Data Sheet is from manufacturers of the original components. Vishay Micro-Measurements specifically disclaims any and all form of liability and/or responsibility for the application of this product.



MATERIAL SAFETY DATA SHEET

SECTION 1: CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT: M-Prep Conditioner A

January 3, 2003

Vishay Micro-Measurements
Post Office Box 27777
Raleigh, NC 27611

MSDS # MGM046K

919-365-3800

CHEMTREC 1-800-424-9300 (U.S.)
703-527-3887 (Outside U.S.)

NOTE: CHEMTREC numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

SECTION 2: HAZARDOUS INGREDIENTS / IDENTITY INFORMATION

CAS NUMBER	CHEMICAL IDENTITY	%
7664-38-2	Phosphoric Acid	5.0-6.0
7732-18-5	Distilled Water	93.5-94.9

SECTION 3: HEALTH HAZARD DATA

Routes of Entry:

Inhalation: YES **Skin:** YES **Ingestion:** Accidental

Health Hazards (Acute and Chronic): None known.

Carcinogenicity:	NTP:	Not listed
	IARC Monographs:	Not listed
	OSHA Regulated:	Not listed

Signs and Symptoms of Exposure:

INHALATION: May cause severe irritation of respiratory system. In confined areas, vapors in high concentrations are anesthetic. Over-exposure may result in light-headedness and staggering gait. Mist may cause coughing, sneezing, salivation, and difficult breathing.

EYE CONTACT: May cause severe irritation or burns.

SKIN CONTACT: May cause severe irritation or burns.

INGESTION: May cause burns to mouth, throat, and stomach.

Conditions Generally Aggravated by Exposure: None identified.

SECTION 4: EMERGENCY AND FIRST AID PROCEDURES

INHALATION: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Prompt action is essential.

EYE CONTACT: In case of eye contact, immediately flush with plenty of water for at least fifteen minutes. Seek medical aid.

SKIN CONTACT: In case of contact, immediately flush skin with plenty of water for at least fifteen minutes while removing contaminated clothing and shoes. Wash clothing before re-use.

INGESTION: CALL A PHYSICIAN. If swallowed, do NOT induce vomiting. If conscious, give water, milk, or milk of magnesia.

SECTION 5: FIRE AND EXPLOSION HAZARD DATA

Flash Point (Method Used): None

Flammable limits: LEL: N/A UEL: N/A

Extinguishing Media: Will not support combustion or burn.

Special Firefighting Procedures: If product is present in a fire, avoid exposure to skin and eyes from mists and splashes. Firefighters should wear standard protective clothing and adequate respiratory protection.

Unusual Fire and Explosion Hazards: May react with some metals including aluminum, magnesium, and zinc, resulting in evolution of hydrogen gas.

SECTION 6: ACCIDENTAL RELEASE MEASURES

Steps to be taken if material is released or spilled: Ventilate area. Absorb with absorbent material. Flush spill area with plenty of water.

SECTION 7: EXPOSURE CONTROLS -- PERSONAL PROTECTION

Respiratory Protection: Self-contained breathing apparatus is recommended for emergency use.

Ventilation:

Local Exhaust: Keep below TLV
Mechanical: Keep below TLV
Special: N/A
Other: N/A

Protective Gloves: Chemical resistant or rubber gloves recommended.

Eye Protection: Chemical safety glasses and faceshield recommended.

Other Protective Clothing or Equipment: Rubber apron or suitable protective clothing. Eye wash station and safety shower should be available in the work area.

Work / Hygienic Practices: Wash hands thoroughly after using.

SECTION 8: HANDLING AND STORAGE

Precautions to be taken in handling and storing: Store below 80°F (27°C). Keep containers tightly sealed. Avoid storing or mixing with materials containing chlorine.

Other Precautions: Avoid eye and skin contact. Avoid breathing mist.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Boiling Point:	210°F to 212°F (99°C to 100°C)
Vapor Pressure (mmHg):	N/A
Vapor Density (Air = 1):	N/A
Specific Gravity (H₂O = 1):	1.36
Melting Point:	N/A
Evaporation Rate (BuAc = 1):	<1
Volatile Organic Compounds:	None
Solubility in Water:	Complete

Appearance and Odor: Clear to slightly turbid liquid; no odor.

SECTION 10: STABILITY AND REACTIVITY DATA

Stability: Stable.

Conditions to Avoid: N/A

Incompatibility (Materials to Avoid): Alkaline materials and materials containing chlorine.

Hazardous Decomposition or By-products: Oxides of phosphorous.

Hazardous Polymerization: Will not occur.

SECTION 11: TOXICOLOGICAL INFORMATION

Phosphoric Acid

OSHA PEL:	1 mg/m ³ (TWA)
ACGIH TLV:	1 mg/m ³
OTHER:	N/A

Distilled Water

OSHA PEL:	Not established
ACGIH TLV:	Not established
OTHER:	Not established

SECTION 12: DISPOSAL CONSIDERATIONS

Waste Disposal Method: Dispose of in accordance with local, state, and federal environmental regulations.

SECTION 13: TRANSPORTATION INFORMATION

SHIPPING NAME	CLASS	PACKING GROUP	UN NUMBER
Corrosive Liquid, N.O.S. (Phosphoric Acid)	8	III	1760

SECTION 14: REGULATORY INFORMATION**SECTION 313 SUPPLIER NOTIFICATION:**

This product contains a toxic chemical or chemicals (as listed below) subject to the reporting requirements of Section 313 Title III of the Superfund Amendment and Reauthorization Act of 1986 and 40 CFR Part 372.

CAS NUMBER	CHEMICAL NAME	% BY WEIGHT
7664-38-2	Phosphoric Acid	5.0-6.0

TSCA NOTIFICATION:

All components of this product are listed in the Toxic Substance Control Act Chemical Substance Inventory (TSCA).

SECTION 15: OTHER INFORMATION

To the best of our knowledge, the information provided above meets the requirements of the United States Occupational Safety and Health Act and regulations established under 29 CFR 1910.1200 (g)(2)(c)(1)-(4) for a mixture of hazardous chemicals which has not been tested as a whole. The data provided on this Material Safety Data Sheet is from manufacturers of the original components. Vishay Micro-Measurements specifically disclaims any and all form of liability and/or responsibility for the application of this product.



MATERIAL SAFETY DATA SHEET

SECTION 1: CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT: M-Prep Neutralizer 5A

January 3, 2003

Vishay Micro-Measurements
Post Office Box 27777
Raleigh, NC 27611

MSDS # MGM048K

919-365-3800

CHEMTREC 800-424-9300 (U.S.)
703-527-3887 (Outside U.S.)

NOTE: CHEMTREC numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

SECTION 2: HAZARDOUS INGREDIENTS / IDENTITY INFORMATION

CAS NUMBER	CHEMICAL IDENTITY	%
1336-21-6	Ammonium Hydroxide	<0.02
7601-54-9	Trisodium Phosphate	<0.05
1303-96-4	Sodium Tetraborate Pentahydrate	<0.01
7732-18-5	Distilled Water	99.92

SECTION 3: HEALTH HAZARD DATA

Routes of Entry:

Inhalation: YES Skin: YES Ingestion: Accidental

Health Hazards (Acute and Chronic): Ammonium hydroxide is irritating and corrosive to body tissues and a sensitized person may react to even dilute solutions.

Carcinogenicity:	NTP:	Not listed
	IARC Monographs:	Not listed
	OSHA Regulated:	Not listed

Signs and Symptoms of Exposure:

INHALATION: May cause headache, coughing, and possible lung damage (edema and difficulty in breathing). Excessive inhalation of vapors is irritating to the mucous membranes of the respiratory tract.

EYE CONTACT: May cause possible burning and reddening. Liquid contact to the eye can be severely damaging and can result in loss of vision.

SKIN CONTACT: May cause irritation, reddening, and possible burns.

INGESTION: May cause possible burning sensation. Ingestion is corrosive to the digestive tract.

Conditions Generally Aggravated by Exposure: Preclude from exposure anyone with eye or pulmonary disease.

SECTION 4: EMERGENCY AND FIRST AID PROCEDURES
--

INHALATION: Remove to fresh air. If breathing is difficult have a trained person administer oxygen. Keep warm and at rest, and contact physician promptly.

EYE CONTACT: Immediately flush with plenty of water for at least 15 minutes while holding the eyelids open. Contact physician, preferably an ophthalmologist.

SKIN CONTACT: Flush with plenty of water while removing contaminated clothing. Wash affected area with soap and water. Launder contaminated clothing before reuse. Seek medical aid if irritation persists.

INGESTION: If conscious, promptly give lots of water, dilute vinegar, or citrus juices to drink, followed by milk. Do NOT induce vomiting. Contact physician.

SECTION 5: FIRE AND EXPLOSION HAZARD DATA
--

Flash Point (Method Used): NONE

Flammable limits: LEL: N/A UEL: N/A

Extinguishing Media: Will not support combustion.

Special Firefighting Procedures: Use media appropriate to surrounding fire conditions. Use cold water spray to control vapors and cool fire exposed containers.

Unusual Fire and Explosion Hazards: When heated, material will emit anhydrous ammonia vapor which necessitates respiratory and eye protection for firefighting. Use protective clothing.

SECTION 6: ACCIDENTAL RELEASE MEASURES

Steps to be taken if material is released or spilled: Ventilate area. Absorb with absorbent material. Neutralize with dilute acid. Flush spill area with plenty of water.

SECTION 7: EXPOSURE CONTROLS -- PERSONAL PROTECTION

Respiratory Protection: For air contaminants above TLV or permissible limits use NIOSH approved respirator for organic vapors.

Ventilation:

Local Exhaust: Keep below TLV
Mechanical: Keep below TLV
Special: N/A
Other: N/A

Protective Gloves: Neoprene or rubber gloves are recommended.

Eye Protection: Full face shield or chemical safety goggles are recommended.

Other Protective Clothing or Equipment: Rubber apron is recommended. Safety shower and eyewash should be available in work area.

Work / Hygienic Practices: Use good housekeeping practices. Wash thoroughly after use.

SECTION 8: HANDLING AND STORAGE

Precautions to be taken in handling and storing: Store below 80°F (27°C) in dry place. Keep containers tightly sealed.

Other Precautions: Avoid breathing vapors and direct contact.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Boiling Point:	212°F (100°C)
Vapor Pressure (mmHg):	760 mmHg @ 100°C
Vapor Density (Air = 1):	1.0
Specific Gravity (H₂O = 1):	1.0
Melting Point:	32°F (0°C)
Evaporation Rate (BuAc = 1):	<1
Volatile Organic Compounds:	0%
Solubility in Water:	100%

Appearance and Odor: Colorless liquid; mild ammonia odor.

SECTION 10: STABILITY AND REACTIVITY DATA

Stability: Stable.

Conditions to Avoid: Adding Sodium Hydroxide to this material and/or heating will volatilize Ammonia.

Incompatibility (Materials to Avoid): Acids, peroxides, metallic copper, tin, zinc, and their alloys, halogenated compounds.

Hazardous Decomposition or By-products: None known.

Hazardous Polymerization: Will not occur.

SECTION 11: TOXICOLOGICAL INFORMATION**Ammonium Hydroxide**

OSHA PEL:	35 ppm (STEL)
ACGIH TLV:	35 ppm (STEL)
OTHER:	N/A

Trisodium Phosphate

OSHA PEL:	Not established
ACGIH TLV:	Not established
OTHER:	N/A

Sodium Tetraborate Pentahydrate

OSHA PEL:	Not established
ACGIH TLV:	1 mg/m ³
OTHER:	N/A

Distilled Water

OSHA PEL:	Not established
ACGIH TLV:	Not established
OTHER:	N/A

SECTION 12: DISPOSAL CONSIDERATIONS

Waste Disposal Method: Neutralize absorbent material with dilute acid. Dispose of in accordance with local, state, and federal regulations.

SECTION 13: TRANSPORTATION INFORMATION

SHIPPING NAME	CLASS	PACKING GROUP	UN NUMBER
Corrosive Liquids, N.O.S. (Ammonium Hydroxide)	8	III	1760

SECTION 14: REGULATORY INFORMATION**SECTION 313 SUPPLIER NOTIFICATION:**

This product contains a toxic chemical or chemicals (as listed below) subject to the reporting requirements of Section 313 Title III of the Superfund Amendment and Reauthorization Act of 1986 and 40 CFR Part 372.

CAS NUMBER	CHEMICAL NAME	% BY WEIGHT
NONE		

TSCA NOTIFICATION:

All components of this product are listed in the Toxic Substance Control Act Chemical Substance Inventory (TSCA).

SECTION 15: OTHER INFORMATION

To the best of our knowledge, the information provided above meets the requirements of the United States Occupational Safety and Health Act and regulations established under 29 CFR 1910.1200 (g)(2)(c)(1)-(4) for a mixture of hazardous chemicals which has not been tested as a whole. The data provided on this Material Safety Data Sheet is from manufacturers of the original components. Vishay Micro-Measurements specifically disclaims any and all form of liability and/or responsibility for the application of this product.