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Reference: Contract No. C146 for the LIGO Beam Tube Modules

Subject : Qualification Test Cleaning Report
Task Orders #94-1, #94-2, and #95-1

Attached are the original and three copies of the Qualification Test Cleaning Report for Task Orders #94-1, #94-2, and #95-1. These tasks were performed to assess the extent of the contamination, evaluate alternative cleaning methods, and execute the selected cleaning process in the Qualification Test. The report consists of the following items:

Beam Tube Cleaning Report
Calendar of Events
Qualification Test Cleaning and Evaluation Procedures
FTIR Analysis Reports
Caltech Task Orders
CBI Man-hour Charges
CBI Material and Equipment
Change Order Worksheets for Individual Tasks
Sequence of Events, Occurrence of Bleeders Flow Chart
Vertical Cleaning Station Budget Cost Estimate
Horizontal Cleaning Station Budget Cost Estimate
Miscellaneous Component Sketches
Material Data Safety Sheets for Cleaning Agents and Solvents

Please note that these tasks do not include the incorporation of the new cleaning procedures into the module procedures, plans, and estimate. The post bake outgas measurements will provide additional information on the effectiveness of the selected QT cleaning process which will enable confirmation of the module cleaning process. CBI will incorporate the new cleaning procedure into the module plans and procedures if requested by Caltech to do so.

The prices for tasks #94-1, #94-2, and #95-1 are [redacted] and [redacted] respectively, for a total price of [redacted]

Regards,

M. L. Tellalian
Plainfield Engineering

BEAM TUBE QT CLEANING PROCEDURE DEVELOPMENT & EXECUTION

Discovery

The original cleaning procedure specified by Caltech was a 5 step process consisting of a solvent wipe, hot water rinse, two hot applications of a 2% Oakite 33 solution, and a final hot water rinse. CBI determined that the disposal cost and relative ineffectiveness of Oakite 33 solutions warranted the consideration of other procedures. CBI prepared material samples cleaned with the specified Oakite procedure and alternative cleaning procedures for testing by Caltech. As a result of these tests, a steam cleaning procedure was selected for the LIGO beam tubes. The Qualification Test steam cleaning procedure presented at the FDR is CL1QT.

Qualification Test section 22-A was steam cleaned in accordance with CL1QT on October 20, 1994. The rotating steam wand stopped sometime during the cleaning process. Black light inspection of the tube section after cleaning revealed scattered minute spots of contamination on the tube surface. These minute spots of contamination were only apparent when the surface was flushed with a isopropyl alcohol or propanol. Fine streaks of fluorescence were produced when the surface was rinsed with propanol and viewed with ultra-violet light. These streaks are referred to as bleeders.

Task #94-1

Task #94-1 was established to study the occurrence, cause, effect, and source of the contamination. The study revealed that the contamination was wide spread and varied in intensity. Isolated spots of contamination were located and viewed under a microscope which revealed that the contamination was located in relatively deep local depressions in the steel surface. Contaminated solvent was taken from various surfaces by withdrawing the propanol wash containing bleeders with a dropper. The contamination was determined by FTIR laboratory analysis to be hydrocarbon type lubrication oil of the following types:

Silicone oil or grease.
Organic ester (possibly a phthalate ester).
Possibly a small amount of hydrocarbon oil or grease.

The source of the contamination could not be identified.

Task #94-2

Task #94-2 was established to determine the best cleaning technique for Mirachem 500 and to compare the effectiveness of cleaning with Mirachem 500 only to the effectiveness of Mirachem with a propanol rinse. Mirachem representatives were contacted to determine how to best use the Mirachem 500. Tests were conducted to determine the most effective concentration and to evaluate the benefits of foam application. Full strength Mirachem was marginally more effective than solutions diluted with de-ionized water. A 30 gallon capacity foam fire extinguisher was used to develop a large quantity of foam in a relatively short time. Foam produced by hand sprayers and by the fire extinguisher produced relatively large bubbles when compared to the aerosol cans

produced by Mirachem. Foam produced by the aerosol cans lasted approximately 7 minutes on a stationary surface while foam produced by the other methods on a stationary surface would collapse in approximately 2 minutes. However, the primary benefit of foam was due to the dwell time provided by foam clinging to the surface. Foam applied to a horizontal rotating tube was washed off the surface after one revolution. A full strength Mirachem liquid wash was selected for evaluation.

The best results were produced by a three step cleaning process consisting of a Mirachem wash and water rinse, steam cleaning rinse, and propanol wash. Tube cleaning in the horizontal position proved to be more economical than cleaning in the vertical position. The following process was selected for the further evaluation:

1. Liquid full strength Mirachem 500 applied to a rotating horizontal tube section.
2. Pressure wash inclined tube with de-ionized water.
3. Steam rinse inclined tube.
4. 2-propanol wash applied to a rotating horizontal tube.
5. 2-propanol rinse applied to a rotating horizontal tube.

Task #95-1

Task #95-1 was established to develop and execute QT cleaning procedures based on the process identified above. A short section of tube was used to develop the cleaning procedure parameters and to evaluate the procedures prior to cleaning the QT sections. Procedure CLTEST1 was developed to clean the short section of tube in the following manner:

1. Full strength Mirachem 500 liquid was placed in the closed horizontal tube on rollers. The amount of Mirachem used was .2 gallons per foot.
2. The tube section was rotated about the longitudinal axis for 30 minutes at a rate of 1/3 turn per minute.
3. The tube was inclined with a 1:20 slope to drain the Mirachem liquid from the tube. Immediately following the Mirachem bath, the beam tube was pressure rinsed with a rotating spray head at a rate of 3 gallons of de-ionized water per foot at 100 PSI.
4. The inclined beam tube was steam cleaned per procedure CL1QT. The steam cleaning was done at 135 PSI with steam produced from 3 gallons of de-ionized water per minute applied with a wand rotating at 60 RPM moving through the tube at a rate of 6 inches per minute.
5. Isopropyl alcohol was placed in the closed horizontal tube on rollers. The amount of alcohol used was .2 gallons per foot. The tube was rotated for 30 minutes at 1/2 revolutions per minute.
6. The isopropyl alcohol was completely drained and a second isopropyl alcohol wash was executed.

Mirachem and isopropyl alcohol baths were accomplished by setting the tube section horizontally on turning rolls. The cleaning effectiveness was evaluated after each step of the cleaning process by Auger analysis of coupons, FTIR analysis of a longitudinal rinse,

water drop tests, and bleeder tests. Auger analysis was performed by MIT on coupons provided by CBI. Evaluations of the 7' section showed that the tube section became progressively cleaner after each step in the cleaning process.

After trial cleaning of a short tube section, the full cleaning process was selected for the Qualification Test sections. Procedures CLSAMP1, CLDROP-1, and CLBLEED-1 were developed for FTIR samples, water drop tests, and bleeder tests, respectively. Procedures CL4QT and CL5QT were developed for the cleaning of the Qualification Test tube sections and baffles, respectively. Evaluation results for the qualification test sections are contained in the attached "Calendar of Events". Longitudinal samples did not always indicate a reduction in the contamination. This is most likely due to an error in the sampling execution which resulted in segregation of a portion of the sample which was tested. All other tests showed a progressive improvement of the tube cleanliness with each step of the cleaning process.

Attachments:
Calendar of Events

Cleaning & Evaluation Procedures:

- CLTEST1 - "Test to Assess the Effectiveness of Cleaning with Liquid Mirachem 500 and Isopropyl Alcohol"
- CL4QT - "QT Assembly Cleaning Procedure"
- CL5QT - "QT Baffle Cleaning Procedure"
- CLSAMP1 - "Procedure for Obtaining a Cleanliness Assessment Sample"
- CLBLEED1 - "Bleeder Detection by Propanol Rinse with Black Light Inspection"
- CLDROP1 - "Water Drop Break Test for Beam Tube Cleanliness Assessment"

FTIR Analyses Reports

LIGO Project "Task Orders #94-1, #94-2, and #95-1.

CBI Charges to Task Orders #94-1, #94-2, and #95-1.

"Beam Tube Sequence of Events, Occurrence of Bleeder" L. Jones 10/21/94

"Vertical Cleaning Station" Budget Cost (CBI Fax Dated November 4, 1994)

"Horizontal Cleaning Station" Budget Cost (CBI Fax Dated November 23, 1994)

Sketches of cleaning closure heads and coupon attachment details.

Mirachem and 2-Propanol Material Safety Data Sheets

10-19-94 Beam tube assembly 22A was steam cleaned in accordance with CL1QT. The high end of the beam tube was covered with polyethylene to retain the heat in the beam tube assembly. The cleaning head was placed in the high end of the tube and held in position until the local temperature of the tube reached approximately 140°F. At the start of the cleaning process, the steam pressure at the exit of the coil was 125 psi resulting in a spray wand rotation of approximately 40 revolutions per minute.

During the cleaning process a sample of the run-off water was collected to confirm that steam was being applied at the specified rate of 1.5 gallons per minute.

The spray wand was not visible during the cleaning process until the wand was approximately 5' from the low end of the tube. At the end of the steam cleaning process it was discovered that the steam spray wand was not rotating. The wand had stopped rotating at sometime during the cleaning process. It was concluded that the steam cleaning apparatus did not have sufficient pressure at the nozzle to keep the spray wand rotating.

As soon as the beam tube was dry, the inside of the beam tube was blacklight inspected in an attempt to determine where the spray wand stop rotating. During this inspection a 6 to 8 inch wide fluorescent band was observed at the bottom of the beam tube. The fluorescent band ran the entire length of the beam tube and was attributed to flow and ponding of contaminated condensed steam. The point where the spray wand stopped was not apparent from the cleanliness of the tube.

Two ideas were considered to minimize the fluorescent band at the bottom of the beam tubes. The slope of the beam tube could be increased to minimize the water damming up behind the spiral weld seams. In addition, the bottom of the tube could be flushed with de-ionized water during the steam cleaning process to wash away condensed steam.

10-20-94 A Steam Jenny representative came to CBI to adjust the steam cleaner. The fuel flow to the steam cleaner was increased which increased the temperature and pressure of the steam. This provided the additional force needed for the wand of the steam cleaner to run continuously. The steam cleaning apparatus was positioned at the high end of the beam tube and test run for 30 minutes. The spray wand was observed rotating for the 30 minutes without stopping.

A second blacklight inspection was performed to again attempt to determine where the spray wand had stopped rotating and to determine if band of fluorescent contamination on the bottom of the beam tube could be removed with acetone and/or isopropyl alcohol. Random checks were made along the whole length of the beam tube. The contamination on the bottom of the tube was readily removed with acetone or isopropyl alcohol. During these checks, it was discovered that areas that passed the dry blacklight inspection

actually contained minute spots of contamination which would become apparent when the surface was flushed with solvent. The contaminants produced streaks of fluorescence as solvent washed over the surface of the tube. The streaks of fluorescence or "bleeders" varied in frequency and intensity but were found everywhere that was checked.

10-20-94 Beam tube assembly 22B was inspected for bleeders with the wet blacklight technique. The inspection revealed fluorescent contamination on the beam tube walls similar to that in the 22A beam tube assembly. Areas that had weld repairs also exhibited contamination or bleeders. Bleeders were also identified around the circumferential weld between 21B and 21C assemblies. Wet blacklight inspections in the 21B beam tube assembly revealed heavy bleeders on the surface walls.

Inspection of the Hyspan expansion joint also revealed light bleeders.

Inspection of the 14 foot experimental can using the wet blacklight techniques revealed light to medium bleeders which were not evident with a dry blacklight technique.

An inspection using the wet blacklight technique on the 18 in x 4 ft office plate revealed no surface contamination or bleeders.

An inspection using the wet blacklight technique on 12 of the steam cleaned C1 hydrogen outgas coupons revealed no visible bleeders.

Inspection using the wet blacklight inspection technique of the exterior surface of the 22A beam tube assembly revealed gross contamination and bleeders.

10-21-94 An inspection using the wet blacklight technique on sheet material (0.105" thick material) that had been crated and stored revealed light bleeders.

An inspection using the wet blacklight technique on a cut-off section from 21D beam tube assembly revealed heavy bleeders and gross contamination. This cut-off section had never been inside the Plainfield Research Facility.

An inspection using the wet blacklight technique on 12 of the C3 hydrogen outgas coupons (0.105" thick material) revealed no contamination or bleeders.

A blacklight inspection of the isopropyl alcohol cleaned piece of glass did not reveal any contamination or bleeders.

10-24-94 Larry Jones of Caltech visited CBI to witness the bleeder phenomena on a number of components including the interior of section 22-A. Larry Jones took photos of typical bleeders.

A teleconference was held to discuss possible sources of the contamination and possible cleaning alternatives. Marty Tellalian, Steve Peters, Warren Carpenter, Larry Jones, Michael Gemelli, Gerry Stapfer and Rai Weiss participated in the teleconference. The attached chart, "Beam Tube Sequence of Events, Occurrence of Bleeders", was the basis of the discussion.

A teleconference was held with Chuck Sherlock in Houston concerning the recently discovered contamination in the beam tube. Chuck scheduled a flight to Chicago to assist Plainfield in the cleaning process.

10-25-94 Chuck Sherlock arrived at CBI's facility in Plainfield and brought with him one half gallon of the Mirachem 500 cleaning solution. Mirachem 500 had been evaluated in December of 1993 when the steam process was selected.

Two 8 foot long sections of beam tube that had been stored outside at CBI's Plainfield facility were inspected using the wet blacklight technique. The inspection revealed heavy bleeders and contamination on the beam tube wall.

Mirachem representatives recommended a concentration or 1 part Mirachem to 20 or 30 parts of water for mild hydrocarbon contamination. An experiment was performed to assess the cleaning effectiveness of different mix ratios of the Mirachem 500 cleaning solution. The experiment was conducted on the exterior surface of one of the 8 foot long beam tube sections. Four 12" wide by 18" long test areas were marked out on the exterior surface of the tube. Solutions of Mirachem 500 having 1:3, 1:20, and 1:30 Mirachem 500 to water ratios were mixed and sprayed onto three of the four test areas. Isopropyl alcohol was sprayed on the fourth test area. The results were inconclusive. There was not any noticeable visual change in the presence of bleeders for the areas cleaned with the three different mix ratios of the Mirachem 500. The wet blacklight technique was used to assess the mixtures.

The 18 in x 4 ft office plate was re-inspected using the wet blacklight technique and this second inspection revealed bleeders on the surface of the plate. Both surfaces of the plate were thoroughly cleaned with isopropyl alcohol and steam cleaned. Inspection using the dry blacklight technique showed no signs of any contamination or bleeders, however, an inspection using the wet blacklight technique revealed several bleeders. A pinpoint bleeder source in the oxide layer was discovered by flushing with isopropyl alcohol. The bleeder remained after repeated flushing.

The steam cleaner and the steam cleaning apparatus were flushed with isopropyl alcohol and liquid samples collected.

The 14 ft experimental beam tube can was steam cleaned and samples were collected of the liquid that run off. An inspection using the wet blacklight technique revealed light to medium bleeders.

Four foot of the 8 ft can section was steam cleaned with a 1:30 solution of Mirachem 500 to de-ionized water. An inspection using the wet blacklight technique revealed light bleeders. A liquid sample of the fluorescent liquid was collected.

10-27-94 Rai Weiss from MIT arrived at Plainfield Research Facility to investigate the bleeder phenomena.

Four coupons were selected and cut from cut off material from the 21C and 21D beam tube assembly for investigation. These four coupons had bleeders that were located using the wet blacklight technique. The four selected coupons were steam cleaned and the bleeders examined using a microscope.

10-28-94 Rai Weiss performed a Flame Test and a Tesla Coil Test on the oxide surface of the sample coupons. These tests did not reveal signs of contamination.

A liquid sample and filter sample of the contaminated solvent were taken by removing the solvent containing bleeders with a dropper. The contaminated solvents were delivered to Fitzsimmons & Associates for FTIR analysis under CBI purchase order 10-31-003.

10/31/94 The contaminated filter paper was delivered to Fitzsimmons & Associates for FTIR analysis under CBI purchase order 10-31-003 Item #2.

11-01-94 Caltech directed CBI to provide a conceptual design and budget estimate for steam cleaning the beam tube modules in a vertical position. The concept developed had four operating stations that would provide the simultaneous cleaning and final inspection of the beam tube modules in a clean room environment. A steel structure (80 feet tall and 30 feet wide) was proposed to accommodate four beam tube modules. The Steel structure would house the four cleaning stations as described below:

Station #1 (Steam Clean with Detergent): At this station the beam tubes are steam cleaned in the vertical position with Mirachem 500 solution. A special steam cleaning apparatus is proposed. A donut shaped ring with multiple spray nozzles that would clean the beam tube from top to bottom. At the bottom the used Mirachem solution is collected, filtered and drained into the local sewer system.

Station #2 (Steam Rinse): At this station the beam tube from station #1 is rinsed from top to bottom with steam. At the bottom the rinse water is collected, filtered, and drained into the local sewer system.

Station #3 (Solvent Rinse): At this station the beam tube from station #2 is rinsed from top to bottom with isopropyl alcohol. An apparatus is used similar to the apparatus used at station #1. At the bottom the used isopropyl alcohol is collected, filtered, and distilled for reuse.
Station #4 (Final Inspection): At this last station the beam tube is inspected before it is capped or sealed. This inspection consists of a blacklight inspection to confirm the cleanliness of the beam tube sections.

11-02-94 The FTIR analysis report dated 11-2-94 was received from Fitzsimmons & Associates for the uncontaminated and contaminated solvent samples submitted on 10/28/94. The uncontaminated 2-Propanol solvent contained 24.5 mg/l of non-volatile matter which appears to be hydrocarbon type lubrication oil. The contaminated solvent contained 180 mg/l of non-volatile matter. The FTIR spectral analysis of the non-volatiles indicates the presence of 2 or more organic compounds which appear to be:

- An organic ester (possibly a Phthalate Ester)
- A silicone oil or grease
- Possibly also a small amount of a hydrocarbon oil or grease.

11-03-94 Don Lee, Vice President of Research for Mirachem, stated that a spray application of Mirachem may not allow sufficient time for the Mirachem to work. Don proposed that a 10% to 20% Mirachem foam solution be applied to the surface for al least one minute followed by a hot water or steam rinse. Mirachem 500 is available in aerosol cans or can be applied with a foaming gun. Mirachem can also be filtered to remove contaminants and re-used. Don stressed the benefits of foam application due to the scrubbing action of the bubbles.

11-04-94 The budget design and cost estimate for vertical cleaning station was completed and submitted to Caltech. See the attached fax from Marty Tellalian to Larry Jones dated November 4, 1994.

11-08-94 Mirachem will send a representative to CBI on November 14. A conference call was held with Don Lee and Larry Jones. Don stated that the key to effective use of Mirachem is time of contact and temperature. Elevated temperatures increase the effectiveness of Mirachem. Mirachem 100 has a small hydrocarbon content and therefor smells like a solvent. Mirachem 500 does not have a hydrocarbon content and has a citrus or tangerine odor. Mirachem 100 and Mirachem 500 work by emulsifying organic compounds. Due to CBI's ability to rotate tube sections containing Mirachem, Don feels that a foam application is not as important as he previously stated.

Received the following results of the FTIR analysis (FTIR report dated 11-8-94) from Fitzsimmons & Associates of the contaminated filter paper taken on 10/28/95:

- The extracted material appears to be a mixture of an ester oil (a fatty acid ester of a polyol) and a hydrocarbon oil.

- This mixture is different from the oils found in the propanol solvent analyzed and reported to you previously (Nov. 2, 1994).
- The oils found in the propanol appeared to be a mixture of silicone oil and a phthalate ester oil.

11-9-94 A 7' section of previously uncleaned tube was selected to develop and evaluate the cleaning procedure to be used for the Qualification Test sections. A longitudinal sample was taken from the 7' tube prior to any cleaning and delivered to Fitzsimmons & Associates for FTIR analysis under CBI purchase order 11-09-003.

11-10-94 Experiments were conducted to assess the effectiveness of Mirachem 500 cleaning solution. A test was performed to compare the relative cleaning effectiveness of Mirachem liquid solutions and Mirachem foams. The following Mirachem solutions and foams were compared:

- Full strength Mirachem 500 solution.
- Mirachem 500 foam from the aerosol can.
- A 1:5 ratio using Mirachem solution and de-ionized water.
- A 1:5 ratio of Mirachem foam from the foam gun.

Four contaminated areas were identified on the exterior surface on the top of the 22B assembly. The areas below each of the selected test areas were inspected using the wet blacklight technique to confirm that they were contaminated and had bleeders.

The test areas were dammed up into a 12" x 12" square. A Water Break Test was performed on the surfaces at each test area. Next, the test areas were covered with the Mirachem solutions or foams. The solutions and foams were allowed to soak for 15 minutes before flushing with de-ionized water and air dried. After drying, a second Water Break Test was performed on the surfaces at each of the four test areas. Each of the four test areas were inspected for bleeders using the wet blacklight inspection technique. The results of these test are summarized below:

MIRACHEM SOLUTION VS MIRACHEM FOAM

Water Break Test Before Cleaning: (Before Mirachem Soak) 12 drops at approximately 0.25" in diameter and 0.093" in height and 80 degree angle from the horizontal.

Blacklight Test: (After Mirachem Soak) The Mirachem foam appeared to remove any smudges or smears that the Mirachem solution did not remove. When isopropyl was applied to both of the cleaned surfaces, small faint bleeders were detected on the Mirachem solution test area only.

Water Break Test After Cleaning: (After Mirachem/Before Isopropyl Flush) 12 drops were applied to each area. The drops in both areas were approximately 0.375" in diameter, 0.031" in height, and had a 30 degree angle from the horizontal.

1:5 MIRACHEM SOLUTION VS 1:5 MIRACHEM FOAM

Water Break Test Before Cleaning: (Before Mirachem Soak) 12 drops were applied to each area. The drops in both areas were approximately 0.25" in diameter, 0.093" in height, and had an 80 degree angle from the horizontal.

Blacklight Test: (After Mirachem Soak) Both of the test areas still appeared to be contaminated under the blacklight when isopropyl was applied to the surface. Bleeders were observed in both areas. The foam gun did not simulate the foaming action supplied from the aerosol can. The bubbles were larger and collapsed after approximately 3 minutes.

Water Break Test After Cleaning: (After Mirachem/Before Isopropyl Flush) 12 drops were applied to each area. The drops in both areas were approximately 0.25" in diameter, 0.093" in height, and had an 80 degree angle from the horizontal.

The tests indicate that the better results for cleaning the beam tube can sections are produced by straight or full concentrate Mirachem Solution or Mirachem Foam compared to a diluted solution of Mirachem solution or foam. Proof of this can be seen through the aid of the Water Break Test, before and after Mirachem, and the Blacklight Inspection with isopropyl flush. No difference was observed in the water break test results for liquid or foam. The black light test indicated slightly better results for full strength foam compared to full strength liquid.

11-11-94 Received the results of the FTIR analysis from Fitzsimmons & Associates of the sample taken from the 7' foot long beam tube before cleaning. The contaminated solvent contained 71.1 ppm of non volatile matter which appeared to be hydrocarbon type oil and extraneous fibers. See the FTIR report dated 11/11/94 for complete results.

11-14-94 Performed a test to assess the application of Mirachem 500 as foam with a rented Ansul Fire Extinguisher Foamer. The ratio of Mirachem solution to de-ionized water was varied to observe the quality of the foam. Prior to applying the foam, the foam fire extinguisher was thoroughly cleaned using isopropyl alcohol and Mirachem. The best foaming results were achieved using straight liquid concentrate without diluting the Mirachem solution. The foam produced with the fire extinguisher is not as stiff nor does it last as long as the foam produced by the aerosol cans.

A representative of Mirachem visited CBI but did not offer any clear direction.

11-17-94 A test was performed to assess the effectiveness of cleaning with liquid Mirachem 500 and isopropyl alcohol. This test consisted of cleaning a short section of the beam tube known as the virgin tube or the 7 ft. beam tube to qualify the cleaning procedure CLTEST. This

procedure assesses the additional cleaning processes proposed for use on the QT and Option beam tube sections. This procedure in short consists of leveling the beam tube on the power rollers and rotating a specified amount of Mirachem solution for 30 minutes. After the 30 minutes, the tube is drained at a 1:20 slope and rinsed using a pressure de-ionized water rinse and de-ionized steam rinse, followed by an isopropyl alcohol wash and isopropyl alcohol rinse. Coupons were placed inside the tube section to provide MIT with material samples at various stages of the cleaning process for Auger testing. Coupon C1 was taken before any cleaning. The 7' tube section was cleaned with a Mirachem bath followed by a water pressure rinse and a stream rinse. The following evaluations were made following the Mirachem wash, water rinse, and steam rinse:

Water Break Test: (After Mirachem Soak, De-ionized Water Rinse, and De-ionized Steam Rinse)
Area 1: 12 drops were applied. All drops were approximately 0.375" in diameter, 0.062" in height, and had an angle of approximated 15 - 20 degrees from the horizontal surface.
Area 2: 12 drops were applied. All drops were approximately 0.375" in diameter, 0.062" in height, and had an angle of approximated 20 - 25 degrees from the horizontal surface.
Area 3: 12 drops were applied. All drops were approximately 0.375" in diameter, 0.062" in height, and had an angle of approximated 15-20 degrees from the horizontal surface.

Blacklight Test with Isopropyl Alcohol: (After Mirachem Soak, De-ionized Water Rinse and De-ionized Steam Rinse)
Initial Pass: 10 fluorescent streaks were observed after the initial 5 ml of isopropyl alcohol was applied to the surface of the beam tube wall (270 degree orientation). 8 out of the 10 streaks observed were actual bleeders coming from pinholes in the oxide layer.

Second Pass: The second pass was applied 2 inches above the first initial pass and used an additional 5 ml of isopropyl alcohol. 12 bleeders or 2 additional bleeders were observed on the surface of the beam tube wall. The original bleeders from the initial pass appeared to be washed away or fainter in color.

Third Pass: The third pass was applied 2 inches above the second pass and used an additional 5 ml of isopropyl alcohol. 13 bleeders or 1 additional bleeder was observed on the surface of the beam tube wall, however, only 3 bleeders still existed after the second and third pass with isopropyl alcohol.

11-18-94 Coupon C2 was removed and a longitudinal sample was taken following the Mirachem wash and water and steam rinse. The contaminated 2-propanol sample and a clean sample were delivered to Fitzsimmons & Associates for FTIR analysis under CBI purchase order 11-18-013. The samples were identified as 2A and 2B. The 7' tube section was then cleaned by washing and rinsing with .2 liters per foot of 2-propanol. Coupon C3 was removed after the 2-propanol wash and Coupon C4 was removed after the 2-propanol rinse. The following evaluations were made following the 2-propanol wash and rinse.

Water Break Test: (After Mirachem Soak, De-ionized Rinse, De-ionized Steam, Isopropyl Wash, and Isopropyl Rinse)

Area 1: 20 drops were applied. All drops were approximately 0.375" in diameter, 0.062" in height, and had an angle of approximated 15 - 20 degrees from the horizontal surface. Water droplet appears to immediately lay flat on the surface when released from the dropper.

Area 2: 20 drops were applied. All drops were approximately 0.375" in diameter, 0.062" in height, and had an angle of approximated 10 - 15 degrees from the horizontal surface. Water droplet lays flat and appears to have a "halo" or "wetting" effect around the droplet.

Area 3: 20 drops were applied. All drops were approximately 0.437" in diameter, 0.062" in height, and had an angle of approximated 10 - 15 degrees from the horizontal surface. Water droplet has the same general characteristics of Area 2, however, the "halo" or "wetting" effect is not as pronounced.

Blacklight Test with Isopropyl Alcohol: (After Mirachem Soak, De-ionized Rinse, De-ionized Steam, Isopropyl Wash, and Isopropyl Rinse)

Initial Pass: The same bleeder check area was retested using 5 ml of isopropyl alcohol. No bleeders were observed on the surface of the beam tube wall (270 degree orientation).

Second Pass: The second pass was applied 2 inches above the first initial pass and used an additional 5 ml of isopropyl alcohol. Again, no bleeders were observed on the surface of the beam tube wall.

Third Pass: The third pass was applied 2 inches above the second pass and required an additional 5 ml of isopropyl alcohol. Still, no indications of any bleeders on the surface of the beam tube wall.

Random Check: Discovered 3 small but faint bleeders outside the bleeder check area, when rinsed with 5 ml of isopropyl alcohol, however, the second and third pass successfully washed them away completely.

11-21-94 A longitudinal sample was taken following the 2-propanol wash and rinse. The contaminated 2-propanol sample and a clean sample were delivered to Fitzsimmons & Associates for FTIR analysis under CBI purchase order 11-22-001. The samples were identified as 3A and 3B.

11-23-94 Received the results of the FTIR analysis from Fitzsimmons & Associates of the sample taken from the 7' foot long beam tube after washing with Mirachem 500, pressure rinsing with de-ionized water and steam cleaning. This was before washing and rinsing with 2-propanol. The contaminated sample contained 18.7 ppm of non volatile matter which appears to be phthalate ester oils. Complete results are provided in the FTIR report dated 11/23/94.

11-24-94 Submitted budget design and estimate for three cleaning methods for the Option to Caltech. See attached fax dated from Marty Tellalian to Larry Jones dated November, 23, 1994.

Received the results of the FTIR analysis from Fitzsimmons & Associates of the sample taken from the 7 'foot long beam tube after washing and rinsing with 2-propanol. The contaminated sample contained 20.0 ppm of non volatile matter which appears to be phthalate ester oils and silicone oils or grease. Complete results are provided in the FTIR report dated 11/24/94.

12-1-94 Two samples of contaminated 2-propanol and one sample of uncontaminated 2-propanol were delivered to Fitzsimmons & Associates for FTIR analysis under CBI purchase order 12-02-007. The contaminated samples were taken from the 2-propanol used to wash and rinse the 7' foot long tube. The contaminated 2-propanol wash was found to contain 210 ppm of predominantly hydrocarbon oil with a smaller amount of ester oil. The contaminated 2-propanol rinse was found to contain 72.5 ppm of predominantly hydrocarbon oil with a smaller amount of ester oil. Complete analysis results are provided in the FTIR report dated 12/6/94.

12-5-94 The following procedures were approved and added to beam tube cleaning procedures which are based on previous qualitative cleaning techniques. They are CL4QT, CLSAMPL1, CLBLEED, and CLDROP1.

12-5-94 Preparations for cleaning the Qualification Test sections have been completed. Began final cleaning the 22-A beam tube Assembly per procedure CL4QT.

Performed the CLSAMPL1 measurement using HPLC Grade Isopropyl Alcohol on section 22-A prior to any cleaning. It was established that the proper amount of alcohol should be 33.5 ml/ft. of beam tube. Beam tube section number 22A is 69.0 ft in length. 2312 ml of Grade HPLC Isopropyl Alcohol was used in the first sample run.

Witness coupons C6, C7, C8 were installed at the elevated end of the beam tube 22A at approximately 90 degrees. Coupon C5 was not subjected to any cleaning. These coupons will be submitted to MIT for Auger analysis after each major step in the cleaning process.

Evaluation of Section 22-A Prior to Cleaning
The Water Break Test was performed on three areas that looked identical under the dry blacklight prior to any cleaning. All three areas exhibited the same results of having a water drop diameter of 0.187 inches, a 70 degree angle, and a height of 0.125 inches.

The first Bleeder Test on interior of beam tube number 22A was performed prior to any cleaning. The test results after the first pass with isopropyl alcohol revealed 11 bleeders, the second pass revealed 7 additional bleeders, and the third pass revealed 5 additional bleeders.

Tube section 22-A was cleaned with 55.7 L of Mirachem 500 while rotating the beam tube on power rollers. After rotating the beam tube for thirty minutes, the one end of the beam tube was elevated and the contaminated Mirachem solution was drained and collected. The tube was then pressured rinsed with de-ionized water using the steam cleaning apparatus.

12-6-94 The beam tube was lowered and leveled into a horizontal position on the power rollers and the end caps were removed. Witness coupon number C6 was removed from the beam tube, packaged, and shipped to Caltech.

Evaluation of Section 22-A After Mirachem Wash & Pressure Water Rinse
The second Water Break Test was performed on three areas that looked identical under the blacklight. All three area exhibited the same results of having a water drop diameter of 0.125 inches, a 65-70 degree angle, and a height of 0.093 inches.

The second Bleeder Test was performed on interior of beam tube number 22A. The test results after the first pass with isopropyl alcohol revealed no bleeders, the second pass revealed no additional bleeders, and the third pass revealed 3 faint bleeders.

The second longitudinal sample was taken in accordance with CLSAMPL1 using HPLC Grade Isopropyl Alcohol. The initial volume amount for the length of tube was 2312 ml and the recovered amount for chemical analysis was 2072 ml.

Section 22-A was then inclined and steam cleaned. The elevated end of the beam tube was covered and temperatures were recorded from the thermocouples and reported in the log book. The temperature and pressure gauges at the output of the steam cleaner were reading 355° F and 130 psi respectively. The steam cleaning apparatus emerged from the low end of the beam tube 2.5 hours later, and the wand was still rotating.

Once the beam tube was dry, it was lowered onto the power rollers and the end cap at the high end of the tube was removed. Witness coupon number C7 was removed from the beam tube, packaged, and shipped to MIT for Auger testing.

Evaluation of Section 22-A After Mirachem Wash, Water Rinse, and Steam Rinse
The third Bleeder Test was performed on the interior of beam tube number 22-A. The test results after the first pass with isopropyl alcohol revealed 14 bleeders, the second pass revealed 24 additional bleeders, and the third pass did not reveal any bleeders.

The third Water Break Test was performed on three areas that looked identical under the blacklight. All three area exhibited the same results of having a water drop diameter of 0.343 inches, a 40-45 degree angle, and a height of 0.093 inches.

The third CLSAMPL1 longitudinal sample was taken using HPLC Grade Isopropyl Alcohol. The initial volume amount for the length of tube was 2312 ml and the recovered amount for chemical analysis was 2060 ml.

The isopropyl alcohol wash was performed using 56 L of solvent while rotating the beam tube on power rollers. After rotating the beam tube for thirty minutes, the end of the beam tube was elevated and the contaminated alcohol drained and collected.

The isopropyl alcohol rinse was performed using 56 liters of solvent while rotating the beam tube on power rolls. After rotating the beam tube for thirty minutes, the end of the beam tube was elevated and the alcohol drained and collected.

Once the beam tube was dried it was lowered onto the power rollers and the end cap at the high end of the tube was removed. Witness coupon number C8 was removed from the beam tube, packaged, and shipped to MIT for Auger testing.

12-7-94 ***Evaluation of Section 22-A After Propanol Wash and Rinse***
The final Water Break Test was performed on three areas of section 22-A that looked identical under the blacklight. All three areas exhibited similar results of having water drops with a diameter of 0.281 inches, a 45-60 degree angle, and a height of 0.093 inches.

The final Bleeder Test on interior of beam tube number 22A was performed. The test results after the first, second and third pass revealed no visible bleeders.

Performed the final CLSAMPL1 measurement for beam tube number 22A using HPLC Grade Isopropyl Alcohol. The initial volume amount for the length of tube was 2312 ml and the recovered amount for chemical analysis was 2070 ml.

Beam tube 22-A was capped and removed from the power rollers to prepare to clean beam tube 22-B. Beam tube 22-B was examined for areas to perform the qualitative cleaning procedures CLSAMPL1, CLBLEED, AND CLDROP1.

Evaluation of Section 22-B Prior to Cleaning

The first Bleeder Test was performed on interior of beam tube number 22-B prior to any cleaning. The test results after the first pass with isopropyl alcohol revealed 24 bleeders, the second pass revealed 21 additional bleeders, and the third pass revealed 15 additional bleeders.

The Water Break Test was performed on 22-B on three areas that looked similar under the dry blacklight. All three areas exhibited the same results of having a water drop diameter of 0.281 inches, a 35-55 degree angle, and a height of 0.093 inches.

The longitudinal sample was taken per CLSAMPL1 using HPLC Grade Isopropyl Alcohol. The amount of alcohol applied to the tube was 33.5 ml/ft. of beam tube. The initial volume amount for the length of tube was 2312 ml and the recovered amount for chemical analysis was 2020 ml. Witness coupons C9, C10, C11 were installed at the south end of beam tube 22-B.

12-8-94 The Mirachem wash of section 22-B was performed using 57.32 L of Mirachem 500 solution while rotating the beam tube on power rollers. After rotating the beam tube for thirty minutes, the south end of the beam tube was elevated and the contaminated Mirachem solution drained and collected. The tube was then pressure rinsed using the steam cleaning apparatus and de-ionized water. Witness coupon number C9 was removed from the beam tube, packaged, and shipped to MIT for Auger testing.

Evaluation of Section 22-B After Mirachem Wash & Pressure Water Rinse

The second Water Break Test was performed on three areas that looked similar under the dry blacklight. All three areas exhibited the same results of having a water drop diameter of 0.281 inches, a 40-50 degree angle, and a height of 0.093 inches.

The second Bleeder Test was performed on interior of beam tube number 22-B. The test results after the first pass with isopropyl alcohol revealed no bleeders, the second pass revealed bleeders, and the third pass revealed no bleeders.

The second longitudinal sample was taken per CLSAMPL1 using HPLC Grade Isopropyl Alcohol. The volume amount for the length of tube was 2312 ml and the recovered amount for chemical analysis was 2050 ml.

It was decided that two other random bleeder samples should be examined on the interior surface of beam tube number 22B to see how the results compared with the second bleeder test. Both of these random samples exhibited similar results by revealing no visible bleeders in the first two passes, although one of the random samples in the third pass displayed 5-6 faint bleeders.

Section 22-B was then inclined and steam cleaned. The elevated end of the beam tube was covered and the temperature and pressure gauges at the output of the steam cleaner were reading 325° F and 125 psi, respectively. The steam cleaning apparatus emerged from the low end of the beam tube 2.2 hours later, and the wand was still rotating. Witness coupon number C10 was removed from the beam tube, packaged, and shipped to MIT for Auger analysis.

12-9-94 ***Evaluation of Section 22-B After Mirachem Wash, Water Rinse, & Steam Rinse***
The third Water Break Test was performed on three areas that looked identical under the dry blacklight. All three areas exhibited the same results of having a water drop diameter of 0.562 inches, a 10-15 degree angle, and a height of 0.031 inches. All three water break test areas exhibited the "halo" or wetting effect around the water droplet.

The third Bleeder Test was performed on interior of beam tube number 22-B. The test results after the first pass with isopropyl alcohol revealed 14 bleeders, the second pass revealed 10 additional bleeders, and the third pass revealed 6 bleeders.

The second bleeder area was checked again for bleeders to determine if new bleeders could be found. The second bleeder area recheck revealed no bleeders in the first two passes, however in the third pass 6-8 faint bleeders were counted. Additional random areas of 22-B were examined to determine the presence of bleeders. The random bleeder check area revealed 6 faint bleeders in the first pass, 8 faint bleeders in the second pass, and 10 faint bleeders in the third pass.

The third longitudinal sample was taken per CLSAMPL1 using HPLC Grade Isopropyl Alcohol. The initial volume amount for the length of tube was 2312 ml and the recovered amount for chemical analysis was 2020 ml.

Section 22-B was then placed back on the rollers and washed with isopropyl alcohol per procedure CL4QT using 56 liters of solvent while rotating the beam tube on power rollers. After rotating the beam tube for thirty minutes, one end of the beam tube was elevated and the alcohol drained and collected. Section 22-B was then again placed back on the rollers and rinsed with isopropyl alcohol per procedure CL4QT using 56 liters alcohol. After rotating the beam tube for thirty minutes, one end of the beam tube was elevated and the alcohol drained and collected. During both of these procedures, all the safety precautions specified by CBI Corporate Safety were strictly observed and followed.

12-10-94 Witness coupon number C11 was removed from the beam tube, packaged, and shipped to MIT for Auger analysis.

Evaluation of Section 22-B After Propanol Wash and Rinse

The final longitudinal sample was taken per CLSAMPL1 for beam tube number 22-B using HPLC Grade Isopropyl Alcohol. The initial volume amount for the length of tube was 2312 ml and the recovered amount for chemical analysis was 2050 ml.

The final Water Break Test was performed on three areas that looked identical under the blacklight. All three area exhibited the similar results of having a water drop diameter of 0.312 inches, a 45-50 degree angle, and a height of 0.062 inches.

The final Bleeder Test was performed on interior of beam tube number 22-B. The test results after the first, second and third pass revealed no visible bleeders. The third bleeder test area was tested again for bleeders and no visible bleeders were seen.

12-12-94 Four samples of contaminated alcohol and one sample of uncontaminated alcohol taken per CLSAMP1 were delivered to Fitzsimmons & Associates for FTIR analysis. The contaminated samples were taken from the 22-A beam tube at the following times during the cleaning process:

- Before the wash with Mirachem 500
- After the rinse with de-ionized water and before steam cleaning
- After steam cleaning and before washing with 2-propanol
- After washing and rinsing with 2-propanol

In addition, a control sample and contaminated wash and rinse samples were also delivered for testing.

12-13-94 Four samples of contaminated alcohol and one sample of uncontaminated alcohol taken per CLSAMP1 were delivered to Fitzsimmons & Associates for FTIR analysis. The contaminated samples were taken from the 22-B beam tube at the following times during the cleaning process:

- Before the wash with Mirachem 500
- After the rinse with de-ionized water and before steam cleaning
- After steam cleaning and before washing with alcohol
- After washing and rinsing with alcohol

In addition, contaminated wash and rinse samples were also delivered for testing. All samples from the cleaning of sections 22-A and 22-B were submitted to Fitzsimmons and Associates under CBI purchase order 12-12-005.

12-14-94 The report for all samples relating to Section 22-A was received in a report dated 12/14/95. The contaminates found in the longitudinal samples are a mixture of hydrocarbon oil, ester oil, and other compounds. The quantity of the contaminants decreased through the cleaning process except after the alcohol wash and rinse which showed a slight rise in contaminants. The wash and rinse alcohol had more contaminates than any of the longitudinal samples. The wash contained 43.5 mg/l of a complex mixture of hydrocarbon oil, ester type oil, and other compounds. The rinse contained 28.0 mg/l of

predominantly hydrocarbon oil with a small amount of ester type oil. The wash and rinse control sample contained 13.0 mg/l of hydrocarbon oil or grease.

12-15-94 The report for all samples relating to Section 22-B was received in a report dated 12/15/95. The contaminates found in the longitudinal samples are a mixture of hydrocarbon oil, ester oil, and other compounds. The quantity of the contaminants decreased through the cleaning. The wash and rinse alcohol had more contaminates than any of the longitudinal samples. The wash contained 47.5 mg/l of a complex mixture of hydrocarbon oil, ester type oil, and other compounds. The rinse contained 18.0 mg/l of predominantly hydrocarbon oil with a small amount of ester type oil. The wash and rinse control sample was the same sample provided with Section 22-A and contained 13.0 mg/l of hydrocarbon oil or grease.

01-05-95 Procedure CL5QT was developed for cleaning the baffles which subjects the baffles to the same cleaning process as that which was used for the tube sections. The aluminum covers used to clean the tube sections were inclined about a center support and rolled around the outer edge to provide washing action similar to that produced by the tube rotation on power rolls.

The Mirachem 500 wash, pressure water rinse, and steam rinse were performed. No evaluations were made.

01-06-95 The 2-propanol wash was performed with propanol from the propanol wash of beam tube section 22-B. The 2-propanol rinse was performed with propanol from the propanol rinse of beam tube section 22-B. The baffles were dry black light inspected after cleaning and no fluorescence were observed. The baffles were then sealed in two layers of polyethylene plastic until installation in the beam tube on 01-11-95.

		IDENTIFICATION **CLTEST1**			
TITLE	**TEST TO ASSESS THE EFFECTIVENESS OF CLEANING WITH LIQUID MIRACHEM 500 AND ISOPROPYL ALCOHOL**	REFERENCE NO. **930212**		SHT 1 OF 5	
		OFFICE **RCE**		REVISION **1**	
PRODUCT	**LIGO BEAM TUBE MODULES QUALIFICATION TEST CALIFORNIA INSTITUTE OF TECHNOLOGY**	MADE BY **SWP**	CHKD BY MLT	MADE BY SWP	CHKD BY MLT
		DATE **11/21/94**	DATE **11/21/94**	DATE 11/23/94	DATE 11/23/94

1.0 SCOPE:

1.1 This procedure covers the cleaning of a short section of the beam tube to assess the additional cleaning processes that are proposed for use on the QT and Option beam tubes sections. A Mirachem 500 wash followed immediately by a pressurized water rinse has been added to the cleaning process before the steam cleaning operation and an isopropylalcohol wash followed by an isopropyl alcohol rinse has been added to the cleaning process after the steam cleaning. Also, additional testing operations have been added to assess the effectiveness of the proposed cleaning methods. This procedure is to be completed and the results assessed before the QT beam tubes are final cleaned.

2.0 PERSONNEL CLOTHING REQUIREMENTS:

2.1 Personnel entering beam tube can sections during this cleaning procedure must wear clean room style clothing (coveralls, shoe covers, hair caps and gloves) to minimize further contamination of the beam tube being cleaned.

3.0 EQUIPMENT AND MATERIALS TO BE USED WITH THIS PROCEDURE:

3.1 Equipment:

- Blacklight Inspection equipment and materials . See Procedure BI1N.
- Equipment and materials for collecting liquid alcohol contaminant samplings. See Procedure CLSAMP1.
- Equipment and materials to assess bleeders on the surface. See Procedure CLBLEED1.
- Special end covers with inflatable seals to contain the alcohol liquid and vapor. See sketch SK-03.
- Turning rolls to roll the beam tube sections during the cleaning operation.
- A 90 gph steam generator
- The special steam spaying apparatus for spraying steam on the inside of the beam tube sections.
- Fire extinguishers suitable for use with flammable solvents.
- An air safety meter.
- Flexible air conduit for venting alcohol vapors from the beam tube to the paint spray booth ventilating system.
- HEPA filter to filter the air entering the beam tube during the venting of the alcohol vapors.
- Two spill containment boxes. One for each end of the beam tube.
- One or more fans to blow air away from the ends of the beam tube.
- Clean empty containers to collect and store spent alcohol.
- Brackets for mounting two cleaning witness coupons to the inside if the beam tube.
- Respirators for alcohol vapors.

3.2 Materials:

- Liquid Mirachem 500 cleaner. (0.2 gallons per foot of tube length)
- 2-Propanol (Isopropyl Alcohol, 99.5+%, A.C.S. reagent, ≥ 0.001% evaporated residue) for alcohol wash and rinse. (0.4 gallons per foot of tube length)
- Deionized Water pressurized water and steam rinses. (6 gallons per foot of tube length).
- Fuel for the steam cleaner.
- Clean polyethylene and duct tape to seal the ends of the tube after cleaning is complete.
- Three 3/8" wide by 13" long cleaning witness coupons from typical 1/8" thick beam tube material.
- Wrapping film - Static Disapative Film Laminate, National Metalizing # N250-707 (distributed by Caltex Plastics as CP STAT 100).
- No smoking signs and warning tape.

4.0 PRECLEANING INSPECTION AND SPOT CLEANING:

4.1 Select one of the extra beam tube sections for the cleaning test Confirm that the section selected has not been previously cleaned and has typical bleeders. Do not use the 22-A or 22-B QT beam tube assemblies.

4.2 Take a cleanliness assessment sample per procedure CLSAMP1 and have it analyzed for contaminants.

5.0 WASH WITH LIQUID MIRACHEM 500 AND PRESSURE RINSE

5.1 Attach Three (3) cleaning witness coupons to the inside of the beam tube.

5.2 Level the beam tube on the turning rolls. Level to within 1/4 inch from end to end of the beam tube.

5.3 Install polyethylene end covers to contain the cleaning solution. Tape the polyethylene to the outside of the beam tube. Install and tighten nylon binders at the ends of the tube over the polyethylene to seal and hold in place.

5.4 Pour the Mirachem 500 liquid into the section of beam tube. Use a quantity of Mirachem equal to 760 milliliters for each foot of length of the beam tube.

5.5 Immediately start the turning rolls and rotate for 30 minutes at the rate of one third (1/3) of a turn per minute.

5.6 Stop rotating the tube after 30 minutes, slope the beam tube to a 1 : 20 slope and drain the Mirachem liquid from the tube. Drain the Mirachem into a clean container and save. Do not stop and drain over locations of cleanliness assessment samples orcleanliness witness coupons.

5.7 Pressure rinse each foot of beam tube with 3 gallons of Deionized water . Use the steam spraying apparatus to apply the rinse water. Cap one of the two spray nozzles to increase the pressure of the water being sprayed. Record the water pressure.

5.8 Steam clean the beam tube section with steam from deionized water at a rate of 3 gallons per foot. Steam clean the beam tube at a rate of six (6) inches per minute.

5.9 Allow the beam tube to dry before testing for cleanliness. If testing is not performed immediately after cleaning cover the ends of the beam tube to prevent contamination.

6.0 TESTS TO ASSESS EFFECTIVENESS OF THE WASH WITH MIRACHEM 500

- Remove one of the cleaning witness coupons, wrap the coupon in the CP STAT 100 wrapping material and ship the coupon along with an uncleaned coupon to Rai Weiss at the following address:

  Rainer Weiss
  Room 20B145
  MIT
  18 Vassar Street
  Cambridge, MA 02139

- Perform the water break test per procedure CLDROP1.
- Take a cleanliness assessment sample per procedure CLSAMP1.
- Inspect the inside surface for bleeders per procedure CLBLEED1.

7.0 SPECIAL SAFETY PROVISIONS FOR THE ALCOHOL WASH AND RINSE OPERATIONS

7.1 Rope off the test area and place warning signs. Place warning tape and signs at doors and other accesses into the test area.

7.2 Open the high bay door and place a fan upstream of the beam tube being cleaned to blow air away from beam tube toward the high bay door. Position the idler turning rolls at the downstream end and the power turning rolls at the upstream end of the beam tube. The upstream end is the end of the beam tube that is raised to drain the alcohol from the beam tube after the alcohol wash and rinse.

7.3 Cover the gratings to the spill containers with plastic and position the grating to provide an opening large enough to handle spillage from the tube in case the end caps develop a leak during the alcohol cleaning and draining operation.

7.4 Turn on blower to the paint hood and open the butterfly valve to vent through the hood before starting the alcohol wash.

7.5 Provide a hole in the aluminum tube cap at the vent/drain end to permit sampling of the air inside the tube during the venting operation.

7.6 Place the air safety meter at the motor to the turning rolls and sample the air from the time the alcohol is poured into the beam tube until the alcohol has been drained and vented from thebeam tube. If at any time during the alcohol cleaning process the LEL reading becomes greater than 10% of the LEL - turn off the power to the turning rolls, clear the area of all non essential personnel and determine the source of the vapor or liquid leakage.

7.7 Be prepared to shut down the building ventilation and area electrical in the case of a large alcohol liquid or vapor leak. Assign two of the cleaning personnel as emergency personnel for the cleaning operation.

7.8 Place fire extinguishers near each end of the beam tube being cleaned.

7.9 Monitor the air inside the beam tube during the venting operation to determine when it is safe to remove the end caps. The LEL inside the beam tube must be less than 10% before the end caps can be removed and the beam tube vented to the room.

7.10 Prohibit access to the ends of the beam tube with the exception of the short periods to inspect the tube interior through the plexiglas window.

8.0 ALCOHOL WASH AND RINSE

8.1 Level the beam tube on the turning rolls. Level to within 1/4 inch from end to end of the beam tube.

8.2 Clean the outside of the beam tube 4" from each end of the tube. Wipe down thoroughly with isopropyl alcohol. Steam clean using deionized waterand wipe the inside of the aluminum end caps with alcohol. Install the aluminum end caps and inflate the seals. Pour a small amount of the isopropyl alcohol (about 300 milliliters) into the bottom of the each end cap and rotate to check for leakage. Be careful not to get the isopropyl alcohol on the inside surface of the beam tube. Cap the six inch vent line and install the 24" square Plexiglas window to seal the 22" square opening.

8.3 Pour the isopropyl alcohol directly into the beam tube through the drain valve or small opening in the cap on the 6" vent nozzle. Use .2 gallons of isopropyl alcohol per foot of tube length. Pour the alcohol into the tube as quickly as possible to minimize the amount of vapor that escapes during the pouring operation.

8.4 Immediately start the turning rolls and rotate the beam tube 4 turns at a rate of 1/2 turn per minute. Monitor the LEL reading near the turning rolls during the operation.

8.5 Slope the beam tube to 1:20 slope and drain the isopropyl alcohol from the beam tube into a clean covered storage container. Allow the tube to drain until the flow rate out of the tube is less than a drop every two seconds. . Do not stop and drain over locations of cleanliness assessment samples orcleanliness witness coupons. Also drain the alcohol from both end caps. Identify and save the drained alcohol.

8.6 Level the beam tube on the turning rolls. Level to within 1/4 inch from end to end of the beam tube.

8.7 Again pour isopropyl alcohol directly into the beam tube through the drain valve or small opening in the cap on the 6" vent nozzle. Use .2 gallons of isopropyl alcohol per foot of tube length. Pour the alcohol into the tube quickly to minimize the amount of vapor that escapes from the beam tube while pouring.

8.8 Immediately start the turning rolls and rotate the beam tube 4 turns at a rate of 1/2 turn per minute. Monitor the LEL reading near the turning rolls during the operation.

8.9 Slope the beam tube to 1 : 20 slope and drain the isopropyl alcohol from the beam tube into a clean storage container. Allow the tube to drain until the flow rate out of the tube is less than a drop every five seconds. Also drain the alcohol from both end caps. Identify and save the drained alcohol.

8.10 Attach the six inch vent hose and install the 24" square HEPA filter and vent the vapors inside the beam tube through the paint hood exhaust system.

8.11 Monitor the air inside the beam tube during the venting operation to determine when it is safe to remove the end caps. The LEL inside the beam tube must be less than 10% before the end caps can be remove and the beam tube vented to the room.

9.0 TESTS TO ASSESS EFFECTIVENESS OF ALCOHOL WASH AND RINSE

- Remove the remaining e cleaning witness coupons, wrap the coupon in the CP STAT 100 wrapping material and ship the coupon to Rai Weiss at the following address:

  Rainer Weiss
  Room 20B145
  MIT
  18 Vassar Street
  Cambridge, MA 02139

- Perform the water break test per procedure CLDROP1
- Take a cleanliness assessment sample per procedure CLSAMP1.
- Inspect the inside surface for bleeders per procedure CLBLEED1

10.0 DOCUMENTATION

10.1 Document as outlined in this procedure.

		IDENTIFICATION **CL4QT**		
TITLE **QT ASSEMBLY CLEANING PROCEDURE**		REFERENCE NO. **930212**		SHT **1** OF **6**
		OFFICE **RCE**		REVISION **1**
PRODUCT **LIGO BEAM TUBE MODULES QUALIFICATION TEST CALIFORNIA INSTITUTE OF TECHNOLOGY**		MADE BY **SWP**	CHKD BY WLR	MADE BY SWP	CHKD BY MLT
		DATE **11/29/94**	DATE **11/30/94**	DATE 12/5/94	DATE 12/5/94

1.0 SCOPE:

1.1 This procedure covers the final cleaning of QT beam tube assemblies and the testing to assess the effectiveness of the cleaning process. The inside surface of each of the beam tube assemblies will be washed with Mirachem 500, pressure rinsed with deionized water, steam cleaned, washed with isopropyl alcohol, and rinsed with isopropyl alcohol. Tests are included to assess the effectiveness of the cleaning process on the QT beam tube assemblies.

2.0 PERSONNEL CLOTHING REQUIREMENTS:

2.1 Personnel entering beam tube can sections during this cleaning procedure must wear clean room style clothing (coveralls, shoe covers, hair caps and gloves) to minimize further contamination of the beam tube being cleaned. When isopropyl alcohol is in use see the Material Safety Data Sheet (MSDS) for the appropriate protective equipment (PPE).

3.0 EQUIPMENT AND MATERIALS TO BE USED WITH THIS PROCEDURE:

3.1 Equipment:

- Blacklight Inspection equipment and materials . See Procedure BI1N.
- Equipment and materials for collecting liquid alcohol contaminant samplings. See Procedure CLSAMP1.
- Equipment and materials to assess bleeders on the surface. See Procedure CLBLEED1.
- Special end covers with inflatable seals to contain the alcohol liquid and vapor.
- Turning rolls to roll the beam tube sections during the cleaning operation.
- A 90 gph steam generator
- The special steam spraying apparatus for spraying steam on the inside of the beam tube sections.
- A 300 gallon polyethylene water storage tank and a water pump (5.3 gpm at 100 psi) to pressure rinse the beam tube with deionized water.
- Fire extinguishers suitable for use with flammable solvents. Use carbon dioxide, dry chemical powder or appropriate foam.
- An air safety meter.
- Flexible air conduit for venting alcohol vapors from the beam tube to the paint spray booth ventilating system.
- HEPA filter to filter the air entering the beam tube during the venting of the alcohol vapors.
- Two spill containment boxes. One for each end of the beam tube.
- One or more fans to blow air away from the ends of the beam tube.
- Clean empty containers to collect and store spent alcohol.
- Brackets for mounting three (3) cleaning witness coupons to the inside of the beam tube.
- Full face respirators for alcohol vapors.

3.2 Materials:

- Liquid Mirachem 500 cleaner. (0.2 gallons per foot of tube length)
- 2-Propanol (Isopropyl Alcohol, 99.5+%, A.C.S. reagent, ≥ 0.001% evaporated residue) for alcohol wash and rinse. (0.4 gallons per foot of tube length).
- Deionized water for the steam cleaning operation (3 gallons per foot of tube length)
- Fuel oil for the steam cleaner.
- Clean polyethylene and duct tape to seal the ends of the tube after cleaning is complete.
- Three 3/8" wide by 13" long cleaning witness coupons from typical 1/8" thick beam tube material.
- Wrapping film - Static Disapative Film Laminate, National Metalizing # N250-707 (distributed by Caltex Plastics as CP STAT 100).
- "No Smoking" signs and warning tape.

4.0 PRECLEANING OPERATIONS:

4.1 Establish four (4) areas for sampling and bleeder checks by blacklight inspection. The areas selected should be representative of the overall tube cleanliness.

4.2 Take a cleanliness assessment sample per procedure CLSAMP1 and have it analyzed for contaminants.

4.3 Install three (3) cleaning witness coupons inside the beam tube at the end that will be raised during cleaning. Do not place witness coupons at the tube bottom or at sampling locations.

4.4 Perform water break test per procedure CLDROP1.

4.5 Perform the bleeder the test per procedure CLBLEED1.

4.6 Steam clean the end covers and wipe the inside surfaces with the 2-Propanol.

5.0 WASH WITH LIQUID MIRACHEM 500 AND PRESSURE RINSE

5.1 Level the beam tube on the turning rolls. The level tolerance shall be 1/4 inch from end to end of the beam tube. The beam tube orientation shall be in the installation position.

5.2 Install the aluminum end covers to contain the Mirachem 500 cleaning solution.

5.3 Pour the Mirachem 500 liquid into the section of beam tube. Use a quantity of Mirachem 500 equal to 0.2 gallons (760 milliliters) for each foot of length of the beam tube.

5.4 Immediately start the turning rolls and rotate for 30 minutes at the rate of one third (1/3) of a turn per minute.

5.5 Stop rotating the tube after 30 minutes. Orient the beam tube to the installation position. Slope the beam tube to a 1 : 20 slope and drain the Mirachem liquid from the tube. Drain the Mirachem into a clean container and save.

5.6 Pressure rinse each foot of beam tube with 3 gallons of deionized water. Use the 300 gallon water storage tank, water pump and steam spraying apparatus to apply the rinse water.

5.7 Allow the beam tube to dry before testing for cleanliness. If testing is not performed immediately after cleaning, cover the ends of the beam tube to prevent contamination.

6.0 TESTS TO ASSESS EFFECTIVENESS OF THE MIRACHEM WASH AND PRESSURE WATER RINSE

- Remove one of the cleaning witness coupons from inside the beam tube, wrap the coupon individually in the CP STAT 100 wrapping material and ship the coupon along with an uncleaned coupon to Rainer Weiss at the following address:

  Rainer Weiss
  Room 20B145
  MIT
  18 Vassar Street
  Cambridge, MA 02139

- Perform the water break test per procedure CLDROP1.
- Take a cleanliness assessment sample per procedure CLSAMP1.
- Inspect the inside surface for bleeders per procedure CLBLEED1.

7.0 STEAM CLEAN WITH DEIONIZED WATER

7.1 Steam clean the beam tube assembly per procedure CL1QT. Steam clean the beam tube with steam from deionized water. Apply 3 gallons of steam per foot of beam tube length and at a rate of six (6) inches of beam tube length per minute.

7.2 Allow the beam tube to dry before testing for cleanliness. If testing is not performed immediately after cleaning, cover the ends of the beam tube to prevent contamination.

8.0 TESTS TO ASSESS EFFECTIVENESS OF THE MIRACHEM WASH, PRESSURE WATER RINSE AND STEAM CLEANING

- Remove one of the cleaning witness coupons form inside the beam tube, wrap the coupon individually in the CP STAT 100 wrapping material and ship the coupon to Rainer Weiss at the following address:

  Rainer Weiss
  Room 20B145
  MIT
  18 Vassar Street
  Cambridge, MA 02139

- Perform the water break test per procedure CLDROP1.
- Take a cleanliness assessment sample per procedure CLSAMP1.
- Inspect the inside surface for bleeders per procedure CLBLEED1.

9.0 SPECIAL SAFETY PROVISIONS FOR THE ALCOHOL WASH AND RINSE OPERATIONS

9.1 Rope off the test area and place warning signs. Place warning tape and signs at doors and other accesses into the test area.

9.2 Open the high bay door and position a fan to blow air toward the beam tube in the direction of the high bay door. Position the idler turning rolls at the downstream end and the power turning rolls at the upstream end of the beam tube. The upstream end is the end of the beam tube that is raised to drain the alcohol from the beam tube after the alcohol wash and rinse.

9.3 Cover the gratings to the spill containers with plastic and position the grating to provide an opening large enough to handle spillage from the tube in case the end caps develop a leak during the alcohol cleaning and draining operation.

9.4 Turn on blower to the paint hood and open the butterfly valve to vent through the hood before starting the alcohol wash.

9.5 Sample the air inside the tube during the venting operation through a hole in the aluminum cap at the vent/drain end of the beam tube.

9.6 Place the air safety meter at the motor to the turning rolls and sample the air from the time the alcohol is poured into the beam tube until the alcohol has been drained and vented from the beam tube. If at any time during the alcohol cleaning process the LEL reading becomes greater than 10% of the LEL - turn off the power to the turning rolls, clear the area of all non essential personnel and determine the source of the vapor or liquid leakage.

9.7 Be prepared to shut down the building ventilation and area electrical in the case of a large alcohol liquid or vapor leak. Assign two of the cleaning personnel as emergency personnel for the cleaning operation.

9.8 Place fire extinguishers (dry chemical powder or carbon dioxide) near each end of the beam tube being cleaned.

9.9 Monitor the air inside the beam tube during the venting operation to determine when it is safe to remove the end caps. The LEL inside the beam tube must be less than 10% before the end caps can be removed and the beam tube vented to the room.

9.10 Prohibit access to the ends of the beam tube with the exception of the short periods to inspect the tube interior through the plexiglas window.

10.0 ALCOHOL WASH AND RINSE

10.1 Level the beam tube on the turning rolls. Level to within 1/4 inch from end to end of the beam tube.

10.2 Clean the outside of the beam tube 4" from each end of the tube. Wipe down thoroughly with isopropyl alcohol. Steam clean using deionized water and wipe the inside of the aluminum end caps with alcohol. Install the aluminum end caps and inflate the seals. Pour a small amount of the isopropyl alcohol (about 300 milliliters) into the bottom of the each end cap and rotate to check for leakage. Be careful not to get the isopropyl alcohol on the inside surface of the beam tube. Cap the six inch vent line and install the 24" square Plexiglas window to seal the 22" square opening.

10.3 Pour the isopropyl alcohol directly into the beam tube through the drain valve or the 6" vent nozzle. Use 0.2 gallons (760 milliliters) of isopropyl alcohol per foot of tube length. Pour the alcohol into the tube as quickly as possible to minimize the amount of vapor that escapes during the pouring operation.

10.4 Immediately start the turning rolls and rotate the beam tube 30 minutes at a rate of 1/2 turn per minute. Monitor the LEL reading near the turning rolls during the operation. After 30 minutes, stop the tube oriented in the installation position.

10.5 Slope the beam tube to a 1 : 20 slope and drain the isopropyl alcohol from the beam tube into a clean covered storage container. Allow the tube to drain until the flow rate out of the tube is less than a drop every second. Do not stop and drain over locations of cleanliness assessment samples or cleanliness witness coupons. Also drain the alcohol from both end caps. Identify and save the drained alcohol.

10.6 Level the beam tube on the turning rolls. Level to within 1/4 inch from end to end of the beam tube.

10.7 Again pour isopropyl alcohol directly into the beam tube through the drain valve or the 6" vent nozzle. Use 0.2 gallons (760 milliliters) of isopropyl alcohol per foot of tube length. Pour the alcohol into the tube quickly to minimize the amount of vapor that escapes from the beam tube while pouring.

10.8 Immediately start the turning rolls and rotate the beam tube 30 minutes at a rate of 1/2 turn per minute. Monitor the LEL reading near the turning rolls during the operation. . After 30 minutes, stop the tube oriented in the installation position.

10.9 Slope the beam tube to a 1 : 20 slope and drain the isopropyl alcohol from the beam tube into a clean storage container. Allow the tube to drain until the flow rate out of the tube is less than a drop per second. Also drain the alcohol from both end caps. Identify and save the drained alcohol.

10.10 Attach the six inch vent hose and install the 24" square HEPA filter and vent the vapors from inside the beam tube through the paint hood exhaust system.

10.11 Monitor the air inside the beam tube during the venting operation to determine when it is safe to remove the end caps. The LEL inside the beam tube must be less than 10% before the end caps can be remove and the beam tube vented to the room.

11.0 TESTS TO ASSESS EFFECTIVENESS OF ALCOHOL WASH AND RINSE

- Remove the remaining cleaning witness coupon, wrap the coupon individually in the CP STAT 100 wrapping material and ship the coupon to Rainer Weiss at the following address:

  Rainer Weiss
  Room 20B145
  MIT
  18 Vassar Street
  Cambridge, MA 02139

- Perform the water break test per procedure CLDROP1
- Take a cleanliness assessment sample per procedure CLSAMP1.
- Inspect the inside surface for bleeders per procedure CLBLEED1

12.0 DOCUMENTATION

12.1 Document as outlined in procedure LIGO CPQT and other referenced procedures.

12.2 Record the identification number, location, and description of the witness coupons.

12.3 Other details may be recorded on the assembly cleaning check list and cleaning log.

		IDENTIFICATION **CL5QT**			
TITLE	**QT BAFFLE CLEANING PROCEDURE**	REFERENCE NO. **930212**		SHT 1 OF 4	
		OFFICE **RDE**		REVISION	
PRODUCT	**LIGO BEAM TUBE MODULES QUALIFICATION TEST CALIFORNIA INSTITUTE OF TECHNOLOGY**	MADE BY **WLR**	CHKD BY SWP	MADE BY	CHKD BY
		DATE **1/5/95**	DATE **1/5/95**	DATE	DATE

1.0 SCOPE:

1.1 This procedure covers the final cleaning of QT baffle assemblies. The surface of each of the baffle assemblies will be washed with Mirachem 500, pressure rinsed with deionized water, steam cleaned, washed with isopropyl alcohol, and rinsed with isopropyl alcohol. The baffles will be cleaned inside a shallow inclined basin that will repeatedly submerge the baffle as the basin is rotated.

2.0 PERSONNEL CLOTHING REQUIREMENTS:

2.1 Personnel handling baffle assemblies after the final cleaning procedure must wear clean room style clothing (coveralls, hair caps and gloves) to minimize contamination of the baffle assembly after cleaning. When isopropyl alcohol is in use, see the Material Safety Data Sheet (MSDS) for the appropriate protective equipment (PPE).

3.0 EQUIPMENT AND MATERIALS TO BE USED WITH THIS PROCEDURE:

3.1 Equipment:

- Blacklight Inspection equipment and materials . See Procedure BI1N.
- A 90 gph steam generator.
- The special steam spraying apparatus for spraying steam on the baffle assemblies.
- A 300 gallon polyethylene water storage tank and a water pump (5.3 gpm at 100 psi) to pressure rinse the beam tube with deionized water.
- Fire extinguishers suitable for use with flammable solvents. Use carbon dioxide, dry chemical powder or appropriate foam.
- An air safety meter.
- Flexible air conduit for venting alcohol vapors from the cleaning area to the paint spray booth ventilating system.
- A shallow cleaning basin. One of the 52" diameter by 6" deep aluminum covers used to cover the ends of the beam tubes during the beam tube cleaning operations will be used as the cleaning basin.
- Two spill containment boxes.
- Clean empty containers to collect and store spent alcohol.
- Full face respirators for alcohol vapors.

3.2 Materials:

- Liquid Mirachem 500 cleaner. (5 gallons)
- 2-Propanol (Isopropyl Alcohol, 99.5+%, A.C.S. reagent, ≥ 0.001% evaporated residue) for alcohol wash and rinse. (5 gallons each). The 2-Propanal used when cleaning the beam tube is acceptable for use.
- Deionized water for the steam cleaning operation (30 gallons)
- Fuel oil for the steam cleaner.
- Clean polyethylene and duct tape to seal the baffle assemblies after cleaning is complete.
- "No Smoking" signs and warning tape.

4.0 PRECLEANING OPERATIONS/Initial Set Up:

4.1 Thoroughly clean the shallow cleaning basin.

4.2 Place the cleaning basin over the two spill containers. Support the basin on the 6' diameter vent port located at the center and an outside edge such that the basin is inclined approximately 13 degrees.

5.0 WASH WITH LIQUID MIRACHEM 500 AND PRESSURE RINSE

5.1 Loosely wire the baffle assembly ends together such that they will fit inside the cleaning basin.

5.2 Cover the cleaning basin with clean polyethylene to contain the Mirachem 500 cleaning solution.

5.3 Pour the Mirachem 500 liquid into the inclined cleaning basin. Use 7.5 gallons of Mirachem 500.

5.4 Tilt and roll the cleaning basin containing the baffle assembly for 30 minutes at roll rate of one third (1/3) of a turn per minute. Cover the baffle assemblies with Mirachem 500. Use a tilting action so that a washing and rinse will take place.

5.5 Stop rolling the cleaning basin and baffle assembly after 30 minutes. Remove the polyethylene cover. Position the cleaning basin with the baffle assembly into a nearly vertical postion for rinsing with pressurized water.

5.6 Pressure rinse the cleaning basin and baffle assemby with 30 gallons of deionized water. Use the 300 gallon water storage tank, water pump and steam spraying apparatus to apply the rinse water.

6.0 STEAM CLEAN WITH DEIONIZED WATER

6.1 Steam clean the baffle assemblies per procedure CL1QT. Steam clean the baffle assemblies with steam from deionized water

6.2 Allow the baffle assemblies to dry.

7.0 SPECIAL SAFETY PROVISIONS FOR THE ALCOHOL WASH AND RINSE OPERATIONS

7.1 Rope off the cleaning area and place warning signs. Place warning tape and signs at doors and other accesses into the test area.

7.2 Re-position the cleaning basin over the two spill containers. Support the basin on the 6' diameter vent port located at the center and an outside edge such that the basin is inclined approximately 13 degrees. Position the spill containers to handle spillage from the cleaning basin and baffle assemblies.

7.3 Re-cover the cleaning basin with clean polyethylene to contain the isopropyl alcohol.

7.4 Turn on blower to the paint hood and open the butterfly valve to vent through the hood before starting the alcohol wash.

7.6 Place the air safety meter in the cleaning area and sample the air from the time the alcohol is poured into the cleaning basin and baffle assembly until the alcohol has been drained and vented. If at any time during the alcohol cleaning process the LEL reading becomes greater than 10% of the LEL - clear the area of all non essential personnel and determine the source of the vapor or liquid leakage.

7.7 Place fire extinguishers (dry chemical powder or carbon dioxide) near cleaning basin.

8.0 ALCOHOL WASH AND RINSE

8.1 Pour the isopropyl alcohol directly into the inclined cleaning basin. Use about 5 gallons of isopropyl alcohol. Pour the alcohol into the cleaning basin as quickly as possible to minimize the amount of vapor that escapes during the pouring operation.

8.2 Tilt and roll the cleaning basin and baffle assembly for 30 minutes at the rolling rate of one third (1/3) of a turn per minute. Monitor the LEL reading during this operation.

8.3 Drain the isopropyl alcohol from cleaning basin into a clean covered storage container.

8.4 Again pour isopropyl alcohol directly into the cleaning basin. Use about 5 gallons of isopropyl alcohol. Pour the alcohol into the cleaning basin as quickly as possible to minimize the amount of vapor that escapes during the pouring operation.

8.5 Tilt and roll the cleaning basin and baffle assembly for 30 minutes at the rolling rate of one third (1/3) of a turn per minute. Monitor the LEL reading during thisoperation.

8.6 Drain the isopropyl alcohol from cleaning basin into a clean covered storage container.

9.0 BLACKLIGHT INSPECT AND PACKAGING BAFFLE ASSEMBLIES

9.1 Remove the wire holding the baffles together. Blacklight inspect per procedure ID No. BI1N.

9.2 Wrap the clean baffle assemby in clean polyethylene attached with clean wire or plastic fasteners. If the baffles are not to be immediately installed, apply an additional wrap of polyethylene wrap and seal the second wrap with tape.

10.0 DOCUMENTATION

10.1 Document as outlined in procedure LIGO CPQT and other referenced procedures.

10.2 Other details may be recorded on the assembly cleaning check list and cleaning log.

		IDENTIFICATION **CLSAMP1**			
TITLE	**PROCEDURE FOR OBTAINING A CLEANLINESS ASSESSMENT SAMPLE**	REFERENCE NO. **930212**		SHT **1** OF **2**	
		OFFICE **RCE**		REVISION **2**	
PRODUCT	**LIGO BEAM TUBE MODULES QUALIFICATION TEST CALIFORNIA INSTITUTE OF TECHNOLOGY**	MADE BY **WLR**	CHKD BY **MLT**	MADE BY SWP	CHKD BY MLT
		DATE **11/8/94**	DATE **11/21/94**	DATE 12/5/94	DATE 12/5/94

1.0 SCOPE

1.1 This procedure details the steps to be followed to obtain a cleaning assessment sample to quantify the surface contaminants from the inside of a section of beam tube. The liquid alcohol sample that is obtained from this procedure will be chemically analyzed to determine the types and amounts of contaminants that have been dissolved in the alcohol from the inside surface of the beam tube.

2.0 EQUIPMENT AND MATERIALS

- Isopropyl Alcohol (2-Propanol, ACS certified, 99.9+%, < 2ppm evaporated residue)
- A graduated cylinder(s) to measure the alcohol. Clean thoroughly with alcohol before using.
- A 4" diameter funnel. Clean thoroughly with alcohol before using.
- Eight (8) 1/2 liter sample containers for each beam tube. Clean thoroughly with alcohol before using.
- Four (4) 2 liter sample containers for each beam tube. Clean thoroughly with alcohol before using.
- A stop watch.

3.0 SUPPLEMENTAL METHODS

3.1 Rotate the beam tube such that the selected sampling area is along the bottom of the beam tube. The area selected should be representative of the general beam tube condition. For the initial sampling of a beam tube not cleaned, the beam tube shall be rotated out of the storage, fabrication, or installation positions. For the ensuing test samples the beam tube shall be rotated out of the mentioned positions and the positions where witness coupons are attached or previous test samples have been taken. Mark the location of the test samples on the outside of the beam tube.

3.2 Take a cleanliness assessment sample as follows:

3.2.1 Slope the beam tube to a 1:20 slope. The expansion joint shall be at the high end of the beam tube.

3.2.2 Place a clean sample collection container at lower end of the beam tube. The container shall be thoroughly cleaned with isopropyl alcohol and dried before use.

3.2.3 Measure length of beam tube. Do not include the expansion joint assembly. The amount of isopropyl alcohol shall be 33.5 milliliter per foot of beam tube length. Measure isopropyl alcohol into a thoroughly cleaned container/delivery system that is equipped to release isopropyl alcohol at a constant flow rate. Measure from the same batch of alcohol a 250 milliliter sample of the uncontaminated isopropyl alcohol and mark the container for comparison testing.

3.2.4 Release the isopropyl alcohol at the upper end below the expansion joint when applicable. The stream shall be kept narrow at the bottom inside of the beam tube. A rate of approximately ten (10) milliliter per second flow will develop a 4" wide channel that should be maintained by stop/start of flow.

3.2.5 Time the flow to determine the amount of time it takes the channel to reach the lower end. Continue the isopropyl alcohol flow until the measured quantity is gone from the container.

3.2.6 Allow the isopropyl alcohol to flow into a thoroughly cleaned funnel and sample collection containers at the low end of the beam tube. Collect all of the sample that flows from the beam tube into the sample collection containers. Continue collecting the sample until the flow is stopped and the droplets are more than two seconds apart.

3.2.7 Measure the amount of isopropyl alcohol collected in the sample collection containers. Mark the collection container with the sample identification number, the container number, the beam tube ID, the type of sample, the date of sample. Record the assembly piece mark, the location of the sample, the volume of isopropyl alcohol delivered into the beam tube, the volume of the sample collected, the sample identification code and the type/description of the sample.

		IDENTIFICATION **CLBLEED-1**			
TITLE	**CLBLEED-1** **BLEEDER DETECTION BY PROPANOL RINSE WITH BLACK LIGHT INSPECTION**	REFERENCE NO. 930212		SHT 1 OF 1	
		OFFICE RCE		REVISION 0	
PRODUCT	**LIGO BEAM TUBE MODULES QUALIFICATION TEST CALIFORNIA INSTITUTE OF TECHNOLOGY**	MADE BY MLT	CHKD BY SWP	MADE BY	CHKD BY
		DATE 11/18/94	DATE 11/21/94	DATE	DATE

1.0 SCOPE:

1.1 This procedure describes the methods to be used to investigate the beam tube surface for the presence of spot contamination as indicated by bleeding lines of fluorescence in a solvent wash when viewed under black light conditions.

2.0 BEAM TUBE ENTRY REQUIREMENTS:

2.1 This procedure can be used on the interior or exterior beam tube surfaces during any stage of the cleaning process. Personnel entering the tube must follow cleanliness procedures consistent with the condition of the tube at the time of entry.

3.0 EQUIPMENT AND MATERIALS TO BE USED WITH THIS PROCEDURE:

3.1 A minimum of 15 ml of reagent grade 2-propanol in a spray bottle. The spray bottle shall be equipped with a tapered nozzle with a pin hole which allows 5 ml of propanol to be applied to a vertical surface in 2 seconds.

3.2 Black light

3.3 Clean, lint free cloth.

4.0 GENERAL PROCEDURE:

4.1 Locate an area with a visual inspection under black light which is representative of the surface being tested. The area should be approximately 12" x 18". Avoid spiral welds and circumferential welds if possible.

4.2 Place the surface in a vertical plane. If an area of the tube is being tested, rotate the tube section such that the area is approximately 4" above and 14" below the horizontal centerline.

4.3 Place a cloth dam 14" below the horizontal center line to prevent propanol from running down the tube more than 14".

4.4 Using a spay bottle with a tapered snout and small discharge hole, apply approximately 5 ml of propanol at the horizontal centerline. The propanol should be applied by squeezing the spray bottle while sliding the snout horizontally over the 12" length in approximately 2 seconds.

4.5 Record the general characteristics of the fluorescence and the number of bleeders identified. Qualitatively assess the intensity of the bleeders and the overall intensity of the fluorescence.

4.6 Approximately 15 seconds after the first propanol wash, apply another 5 ml of propanol in the same fashion to the surface along a horizontal line 2" above the first wash.

4.7 Again record the characteristics of the fluorescence including the appearance of new bleeders and the condition of existing bleeders.

4.8 Approximately 15 seconds after the second propanol wash, apply another 5 ml of propanol in the same fashion to the surface along a horizontal line 2" above the second wash.

4.9 Again record the characteristics of the fluorescence including the appearance of new bleeders and the condition of the existing bleeders.

		IDENTIFICATION **CLDROP-1**			
TITLE	**CLDROP-1** **WATER DROP BREAK TEST FOR BEAM TUBE CLEANLINESS ASSESSMENT**	REFERENCE NO. 930212		SHT 1 OF 1	
		OFFICE RCE		REVISION 0	
PRODUCT	**LIGO BEAM TUBE MODULES QUALIFICATION TEST CALIFORNIA INSTITUTE OF TECHNOLOGY**	MADE BY MLT	CHKD BY SWP	MADE BY	CHKD BY
		DATE 11/21/94	DATE 11/21/94	DATE	DATE

1.0 SCOPE:

1.1 This procedure describes the methods to be used to assess the beam tube surface cleanliness as indicated by the characteristics of water drops placed on a horizontal surface of the tube.

2.0 BEAM TUBE ENTRY REQUIREMENTS:

2.1 This procedure can be used on the interior or exterior beam tube surfaces during any stage of the cleaning process. Personnel entering the tube must follow cleanliness procedures consistent with the condition of the tube at the time of entry.

3.0 EQUIPMENT AND MATERIALS TO BE USED WITH THIS PROCEDURE:

3.1 De-ionized water.

3.2 Container with a squeeze dropper.

3.3 Clean, lint free cloth.

4.0 GENERAL PROCEDURE:

4.1 Locate three areas by visual inspection under black light which are representative of the surface being tested. Each area should be approximately 6" x6".

4.2 Place the surface in a horizontal plane.

4.3 Using the squeeze dropper, place approximately 15 single drops of water on the surface of one area. Release the drop from the end of the pipette as close to the surface as possible without allowing the drop to be simultaneously in contact with the pipette and the surface. Allow sufficient space between each drop such that the drops do not run together.

4.4 Describe the profile of the water drops including the height of the drop, the diameter of the drop, and the angle between the drop profile and the surface measured from inside the drop. Qualitatively describe the behavior of the water drops for the first minute after the drop is placed on the surface. Record the general characteristics of the water drops.

4.5 Repeat the test on the two other areas.

4.6 Wipe the water drops off the surface with clean, lint free cloth following the test.

R. V. FITZSIMMONS AND ASSOC. INC.
CHEMICAL ANALYSTS AND CONSULTANTS
1860 Arthur Drive
West Chicago, Illinois 60185
(708) 231-0680
FAX: (708) 231-0811

ANALYSIS REPORT FOR:

CBI TECHNICAL SERVICES
1501 N. Division St.
Plainfield, IL 60544

Attn: Steve Peters

PURCHASE ORDER NO: 10-31-003 Rev.0

DATE 11/2/94

REPORT OF MATERIALS ANALYSIS: Analysis of two propanol solutions for non-volatiles content.
Determination of amount and type of non-volatiles.

METHODS: For both the propanol solvent and the contaminated propanol solution, 20 ml of each liquid was quantitatively oven dried in glass petri dishes.
The non-volatile materials left after the oven drying were analyzed by FTIR spectral analysis in a KBr matrix.
A small portion of the contaminated solution was dried on a microscope slide and examined at 100X magnification to identify the insoluble matter in the solution.

RESULTS:

Non-Volatile Content of the Propanol Solvent

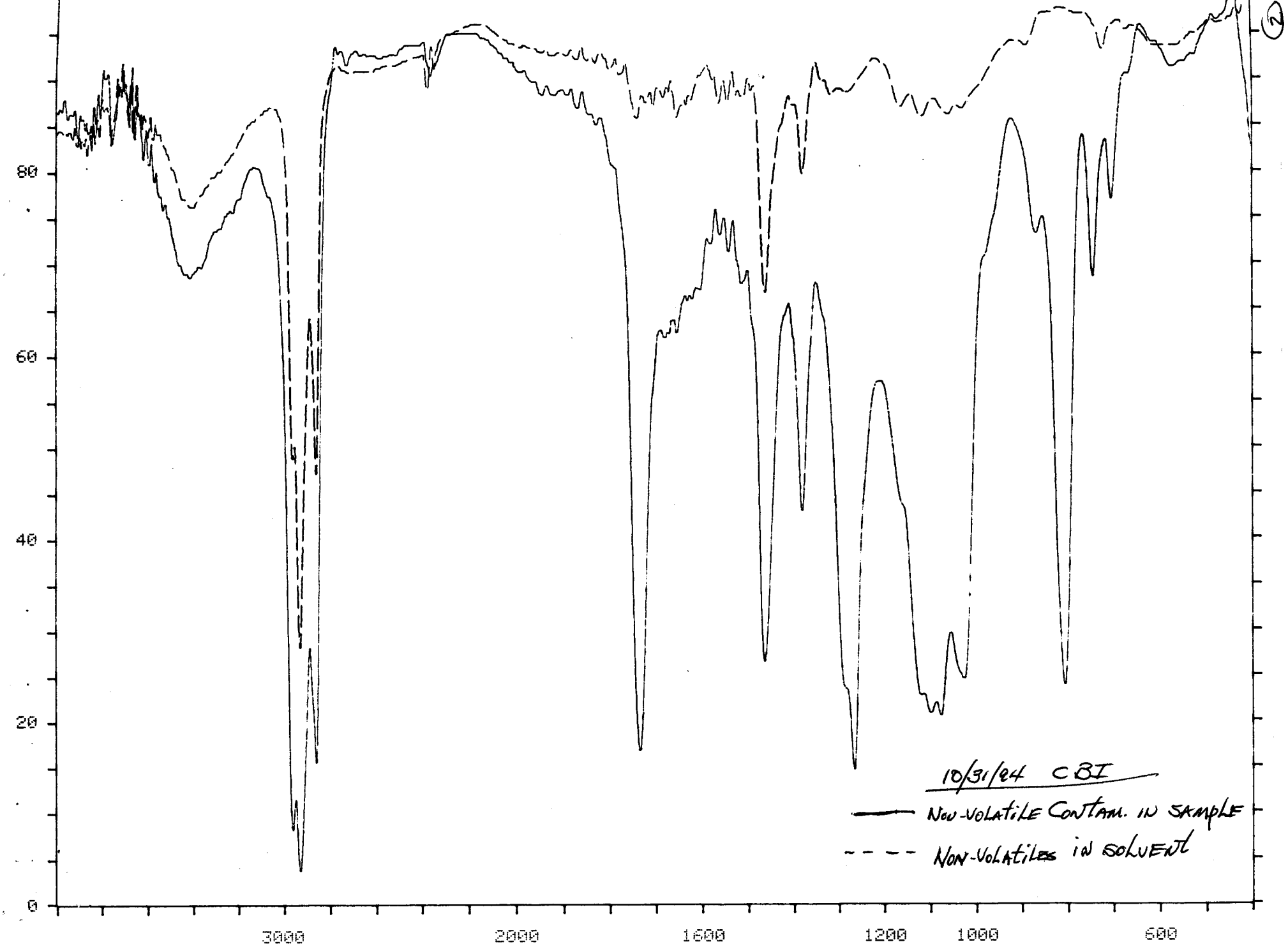
The solvent was found to contain 24.5 mg/l of non-volatile matter which appears to be a hydrocarbon type lubrication oil.

Non-Volatile Content of Contaminated Solution

This solution contained 180mg/l (224 ppm) of non-volatile matter.
FTIR spectral analysis of the Non-volatiles indicates the presence of 2 or more organic componments which appear to be:

- A Silicone oil or grease
- An organic ester (possible a Phthalate Ester)
- Possibly also a small amount of a hydrocarbon oil or grease.

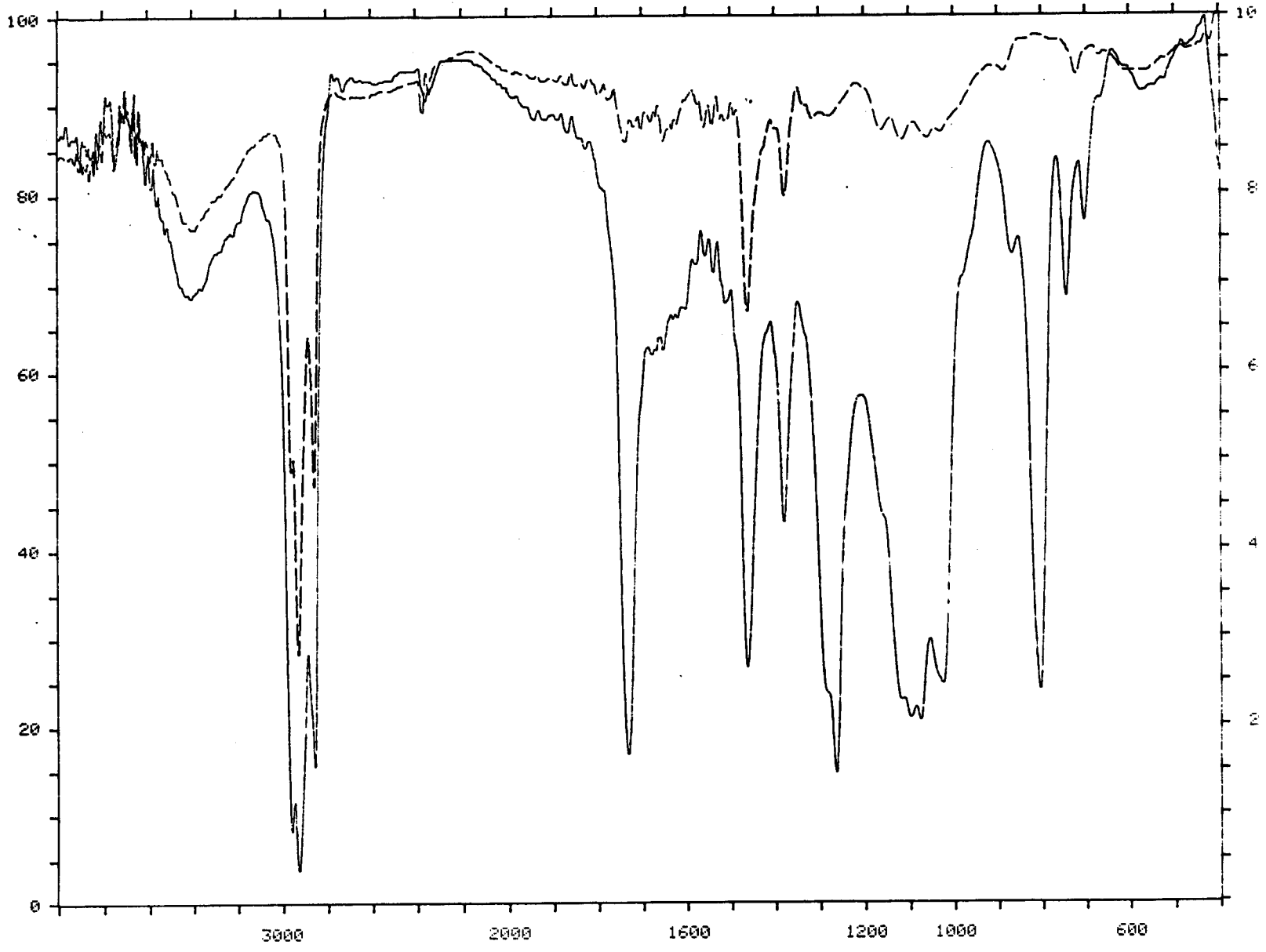
Copies of the FTIR spectra of the non-volatiles are enclosed for your examination.


80
60
40
20
0
3000
2000
1600
1200
1000
600
10/31/84 CBI
NON-VOLATILE CONTAM. IN SAMPLE
NON-VOLATILES IN SOLVENT

10/31/94 - CBI

—— NON. VOLATILE CONTAMINANTS IN SAMPLE

- - - - NON. VOLATILES IN PROPANOL SOLVENT



L&O FILE 461

R. V. TZSIMMONS AND ASS . INC.

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ANALYSIS REPORT FOR:

CBI TECHNICAL SERVICES
1501 N. Division St.
Plainfield, IL 60544

Attn: Martin L. Tellalian

PURCHASE ORDER NO. 10-31-003 Rev.0 ~~Item #2~~

DATE 11/8/94

REPORT OF MATERIALS ANALYSIS: Analysis of the filter paper sample containing contaminants.
Analysis for the propanol extractables (type of extractable materials).

METHODS: A portion of the filter paper was extracted with high purity propanol solvent and the extract taken to dryness at 90 C.
The semi-volatile/non-volatile residue was analyzed by FTIR spectral analysis in a KBr matrix.

RESULTS:

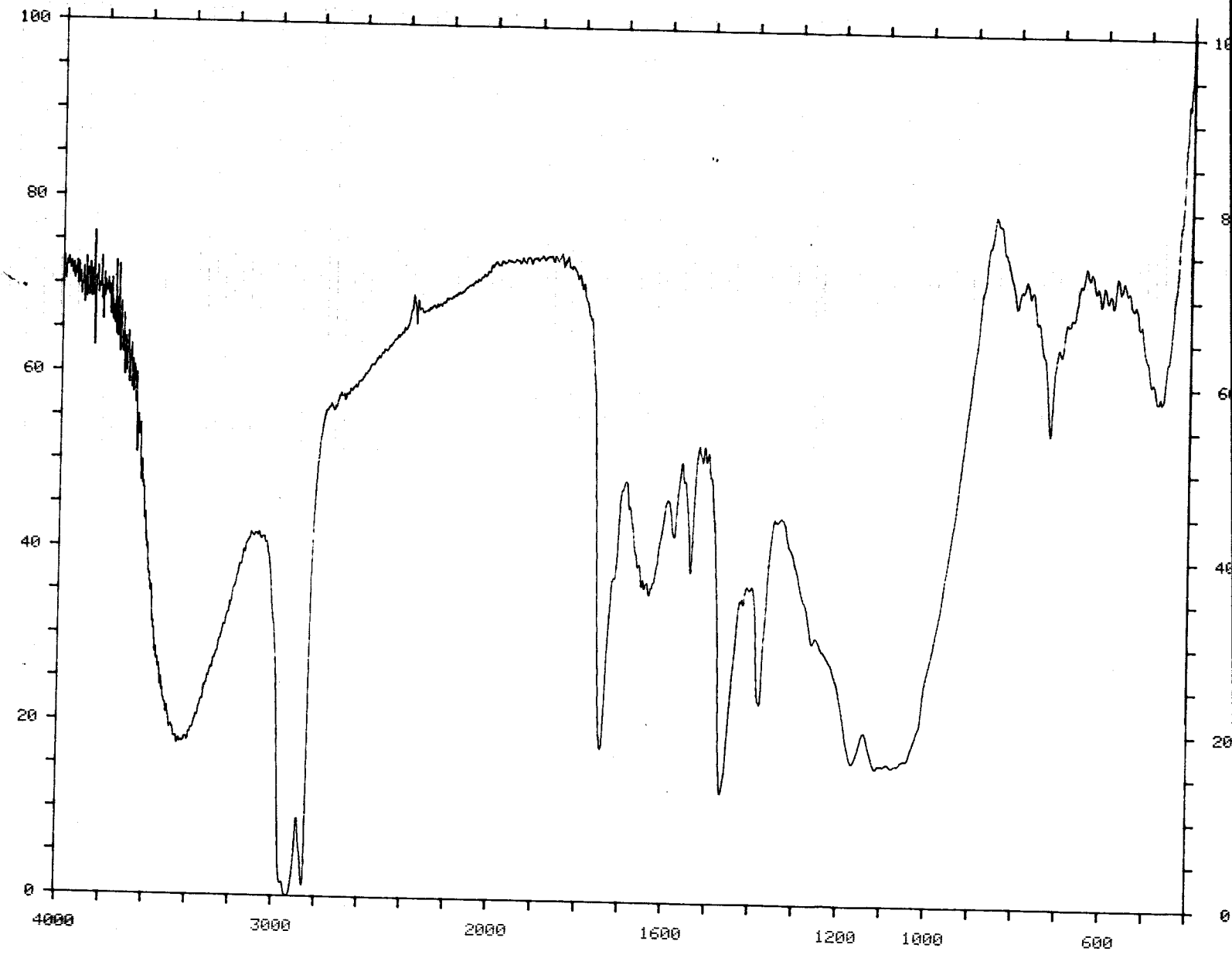
The extracted material appears to be a mixture of an ester oil (a fatty acid ester of a polyol) and a hydrocarbon oil.

This mixture is different from the oils found in the propanol solvent analyzed and reported to you previously (Nov. 2, 1994).
The oils found in the propanol appeared to be a mixture of a silicone oil and a phthalate ester oil.

A copy of the FTIR spectra used in this identification will be included with your report.

(5)

11/7/94 - ~~CBT~~
Alcohol Ext of Filter



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~~ALT~~ 930212 FILE 9.2

ANALYSIS REPORT FOR:

CBI TECHNICAL SERVICES
1501 N. Division St.
Plainfield, IL 60544

Attn: Steve Peters

PURCHASE ORDER NO. 11-09-003 Rev.0

DATE 11/1/94

REPORT OF MATERIALS ANALYSIS: Analysis of two propanol solutions for non-volatiles content.
Determination of amount and type of non-volatiles.

METHODS: For both the propanol solvent and the contaminated propanol solution, 50 ml of each liquid was quantitatively oven dried in glass petri dishes.
The non-volatile materials left after the oven drying were analyzed by FTIR spectral analysis in a KBr matrix.

RESULTS:

Non-Volatile Content of the Propanol Solvent

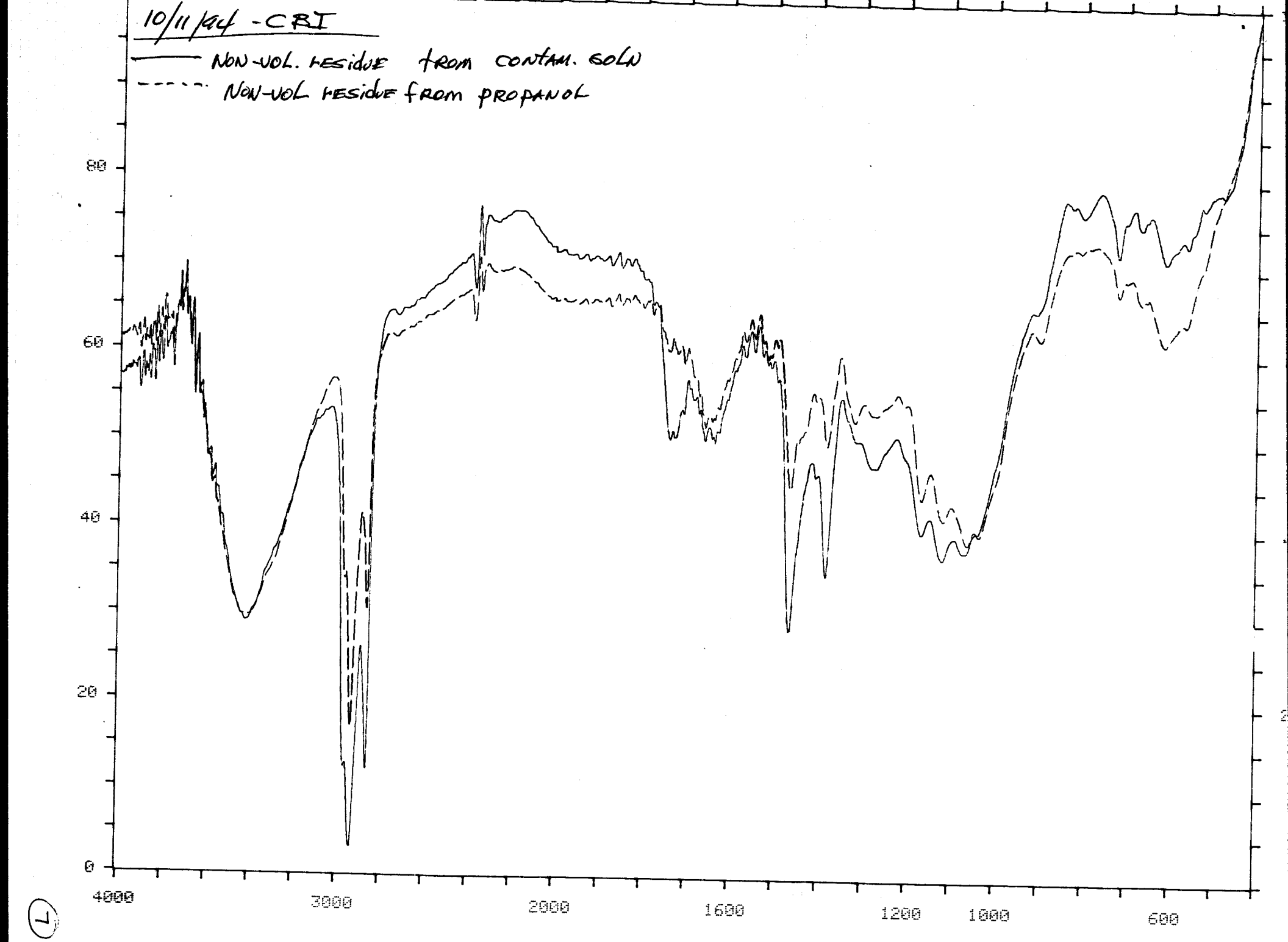
The solvent was found to contain 27.5 ppm of non-volatile matter which appears to contain a hydrocarbon type oil and other extraneous matter such as fibers.

Non-Volatile Content of Contaminated Solution

This solution contained 56.mg/l (71.ppm) of non-volatile matter.
FTIR spectral analysis of the non-volatiles indicates that a hydrocarbon oil or grease and other miscellaneous matter is present in the non-volatile matter. This is quite similar to the non-volatiles of the propanol solvent.

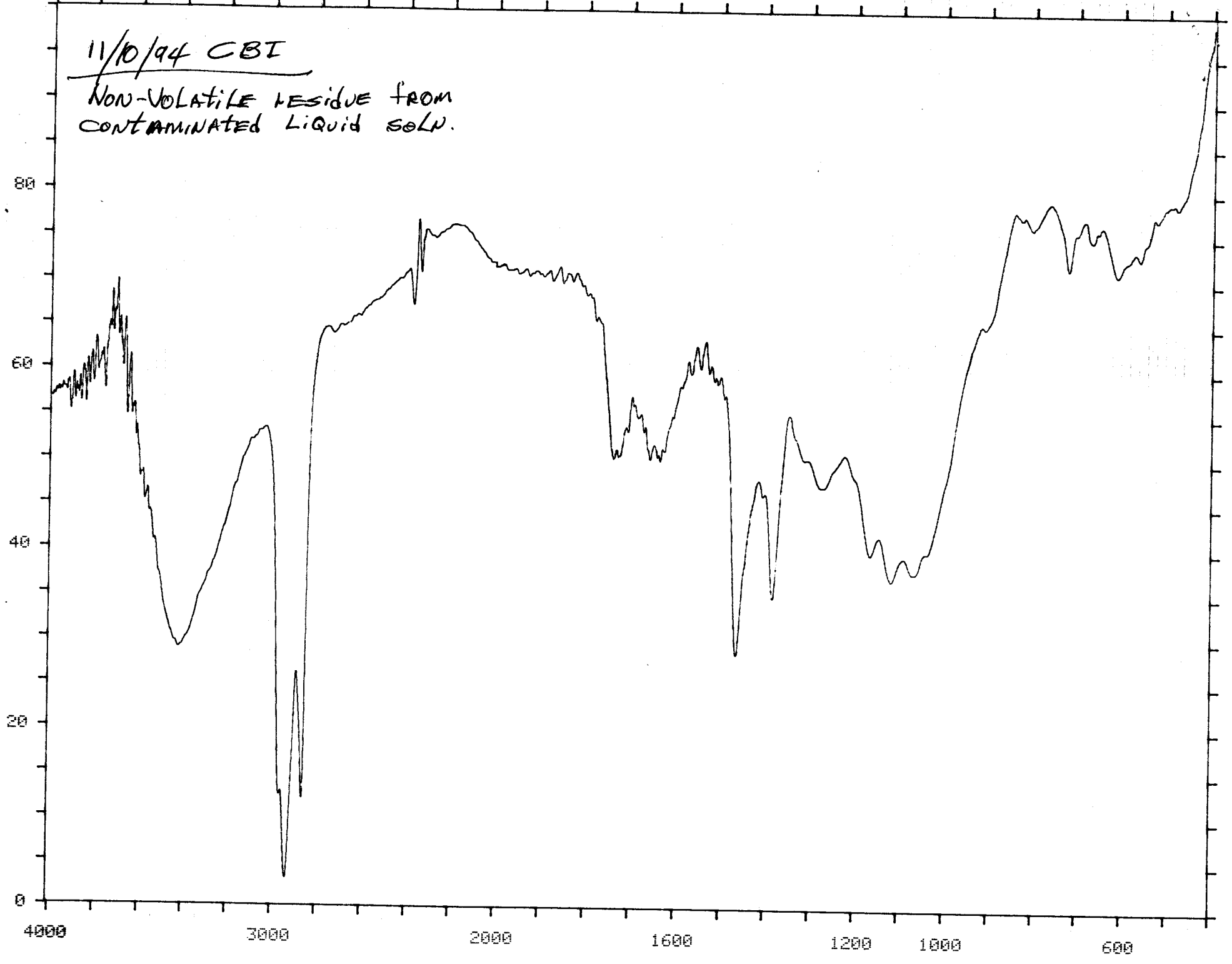
The contaminants found in the earlier solutions that we analyzed for you (Nov. 2, 1994 report) did not seem to be present here in significant amounts.

Copies of the FTIR spectra used in these identifications are enclosed for your examination.
Copies of the FTIR spectra of the non-volatiles are enclosed for your examination.


10/11/94 - CRI
NON-VOL. RESIDUE FROM CONTAM. SOLN
NON-VOL RESIDUE FROM PROPANOL
80
60
40
20
0
4000
3000
2000
1600
1200
1000
600

11/10/94 CBI

NON-VOLATILE RESIDUE FROM CONTAMINATED LIQUID SOLN.



(2)

R. V. FITZSIMMONS AND ASSOC. INC.

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FAX: (708) 231-0811

ANALYSIS REPORT FOR:

CBI TECHNICAL SERVICES
1501 N. Division St.
Plainfield, IL 60544

Attn: ~~Steve Peters~~ → [illegible]

PURCHASE ORDER NO. 8-013 Rev.0

DATE 11/23/94

REPORT OF MATERIALS ANALYSIS: Analysis of two propanol solutions for non-volatiles content. These samples were taken after cleaning with Merichem 500, then pressure rinsing with deionized water and steam cleaning.
Samples submitted 11/18/94: 2a and 2b and control solvent.
Determination of amount and type of non-volatiles.

100 ml per B. Fitzsimmons 12/1/94

METHODS: For both the propanol solvent and the contaminated propanol solution, 20 ml of each liquid was quantitatively oven dried in glass petri dishes.
The non-volatile materials left after the oven drying were analyzed by FTIR spectral analysis in a KBr matrix.
A small portion of the contaminated solution was dried on a microscope slide and examined at 100X magnification to identify the insoluble matter in the solution.
Copies of the FTIR spectra enclosed.

RESULTS:

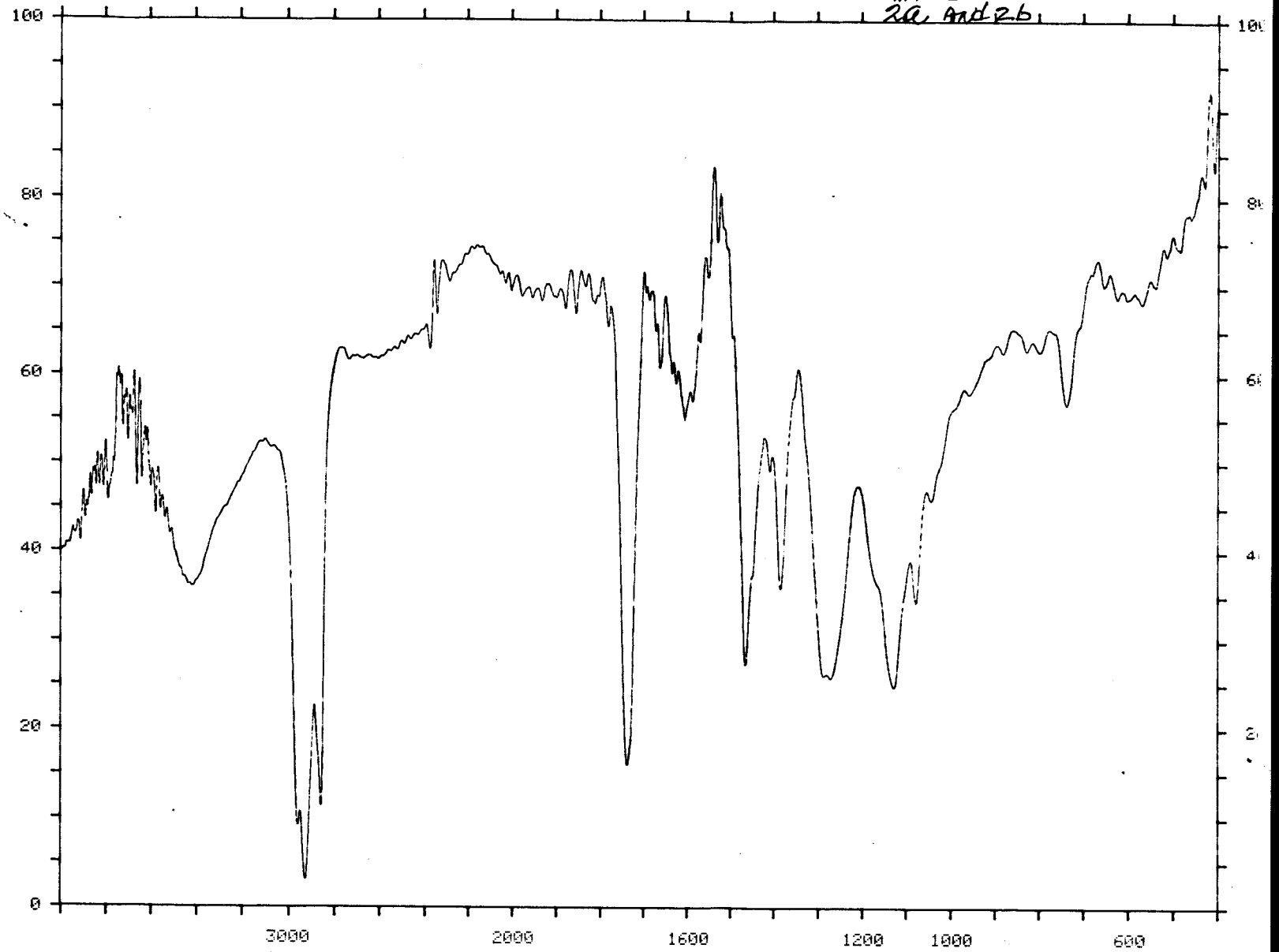
Non-Volatile Content of the Propanol Solvent

The solvent was found to contain 3.0 mg/l of non-volatile matter which is identified as predominantly a phthalate ester oil. This is one of the components found in your original samples, reported to you on 11/2/94.

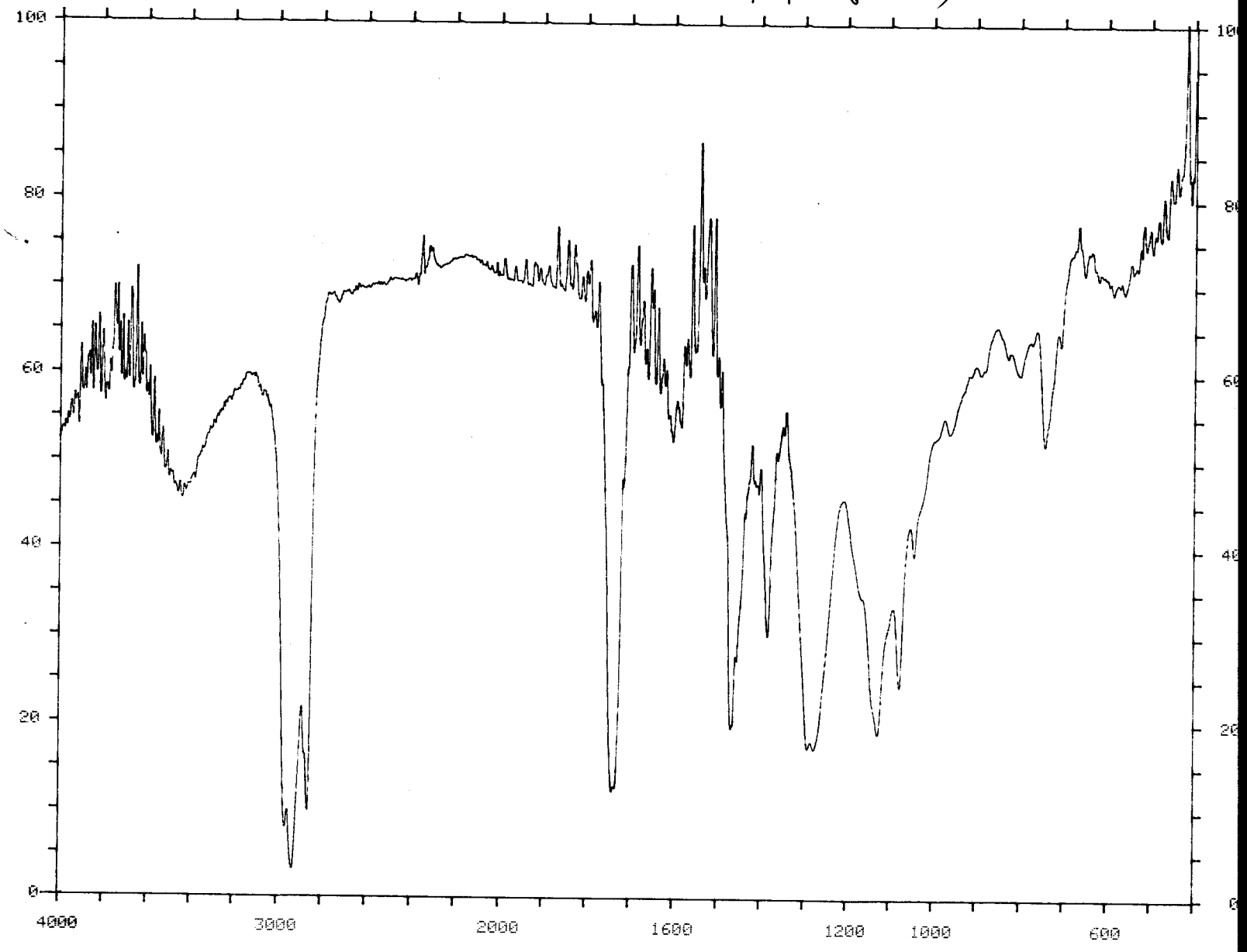
Non-Volatile Content of Contaminated Solution

This solution contained 15.0 mg/l (18.7 ppm) of non-volatile matter.
The non-volatiles here are the same as those found in the propanol solvent control sample, i.e. a phthalate ester oil only there was five times the quantity found here.
Phthalate ester oils are most commonly used as plasticizers in plastics, rubbers and paints and less often used as lubricants.

11/22/94 - CBI
NON-VOLATILE RESIDUES FROM CONTAMINATE SOLVENT WASH SOLUTIONS 2a AND 2b



11/22/94 - CBL
Non-Volatile residues from
propanol (control) solvent



R. V. TZSIMMONS AND ASS . INC.

CHEMICAL ANALYSTS AND CONSULTANTS

1860 Arthur Drive
West Chicago, Illinois 60185

(708) 231-0680
FAX: (708) 231-0811

ANALYSIS REPORT FOR:

CBI TECHNICAL SERVICES
1501 N. Division St.
Plainfield, IL 60544

Attn: ~~Steve Peters~~ [illegible]

PURCHASE ORDER NO. 11-22-001 Rev.0

DATE 11/24/94

REPORT OF MATERIALS ANALYSIS: Analysis of two propanol solutions for non-volatiles content. These samples were taken after cleaning the metal surface by washing with 2-propanol
Samples submitted 11/21/94: 3a and 3b and control solvent.
Determination of amount and type of non-volatiles.

METHODS: For both the propanol solvent and the contaminated propanol solution, 100ml of each liquid was quantitatively oven dried in glass petri dishes.
The non-volatile materials left after the oven drying were analyzed by FTIR spectral analysis in a KBr matrix.

RESULTS:

Non-Volatile Content of the Propanol Solvent

The solvent was found to contain 2.0 mg/l of non-volatile matter which is identified as a mixture of silicone oil or grease and a phthalate ester oil very similar to the mixture of non-volatiles found in your original contaminated liquid solvent which was reported to you on 11/2/94.

Non-Volatile Content of Contaminated Solution

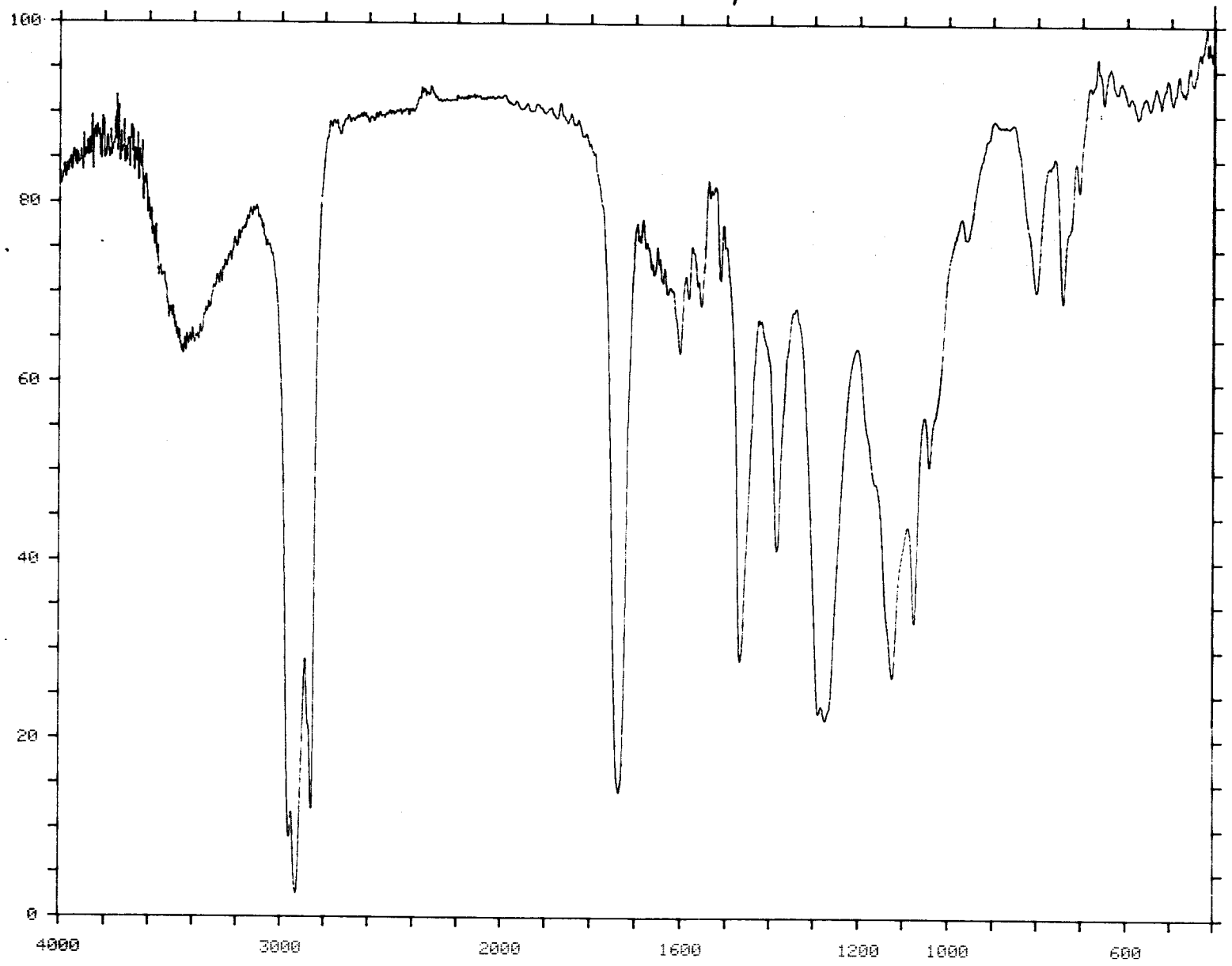
This solution contained 16.0 mg/l (20.0 ppm) of non-volatile matter.
The non-volatiles here are the same as those found in the propanol solvent control sample, i.e. a mixture or silicone oil or grease and phthalate ester oil similar to the non-volatiles found in the contaminated solution reported to you on 11/2/94.

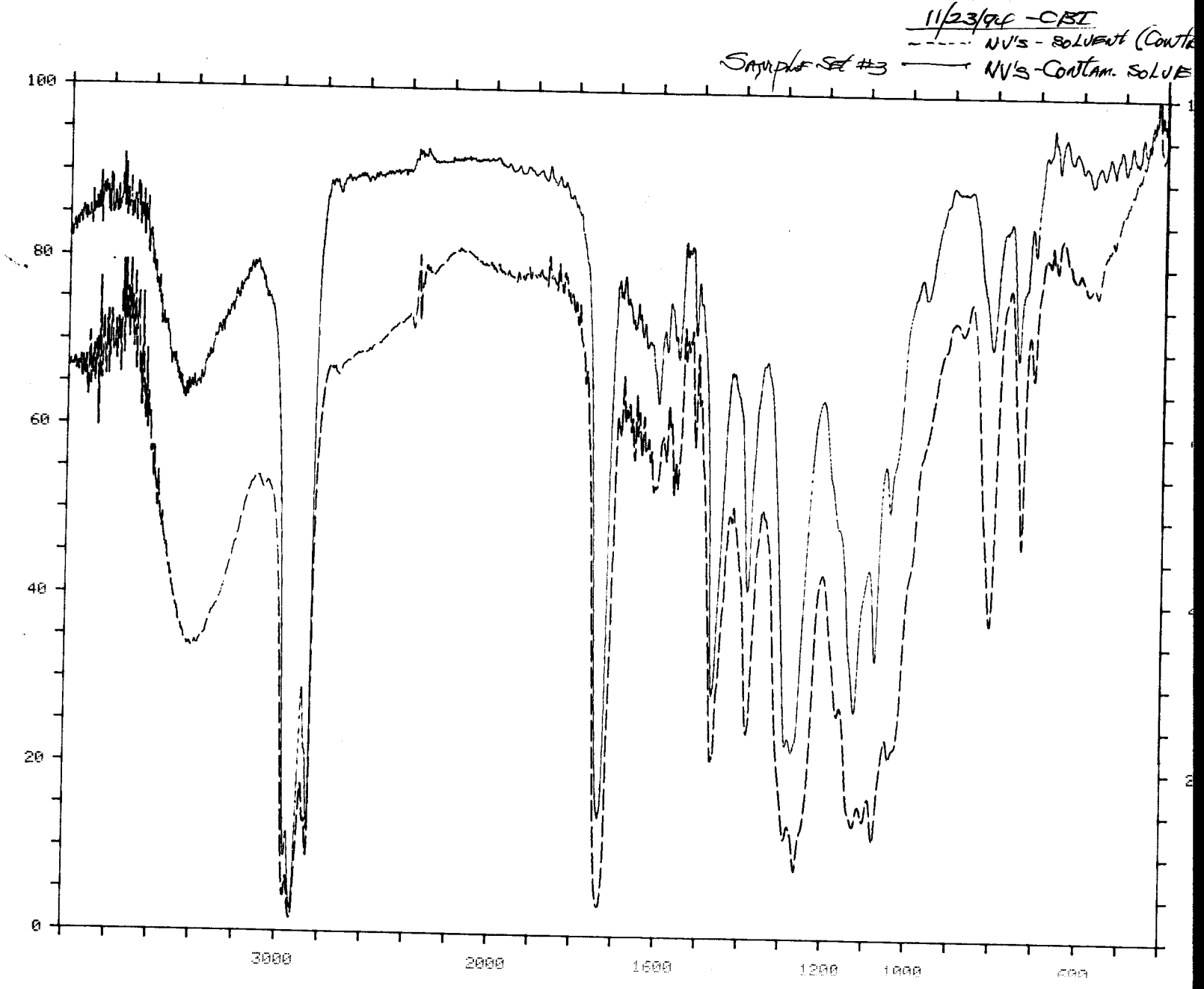
Copies of the FTIR spectra used in these identifications will be sent with this report.

(13)

SAMPLE SET #3

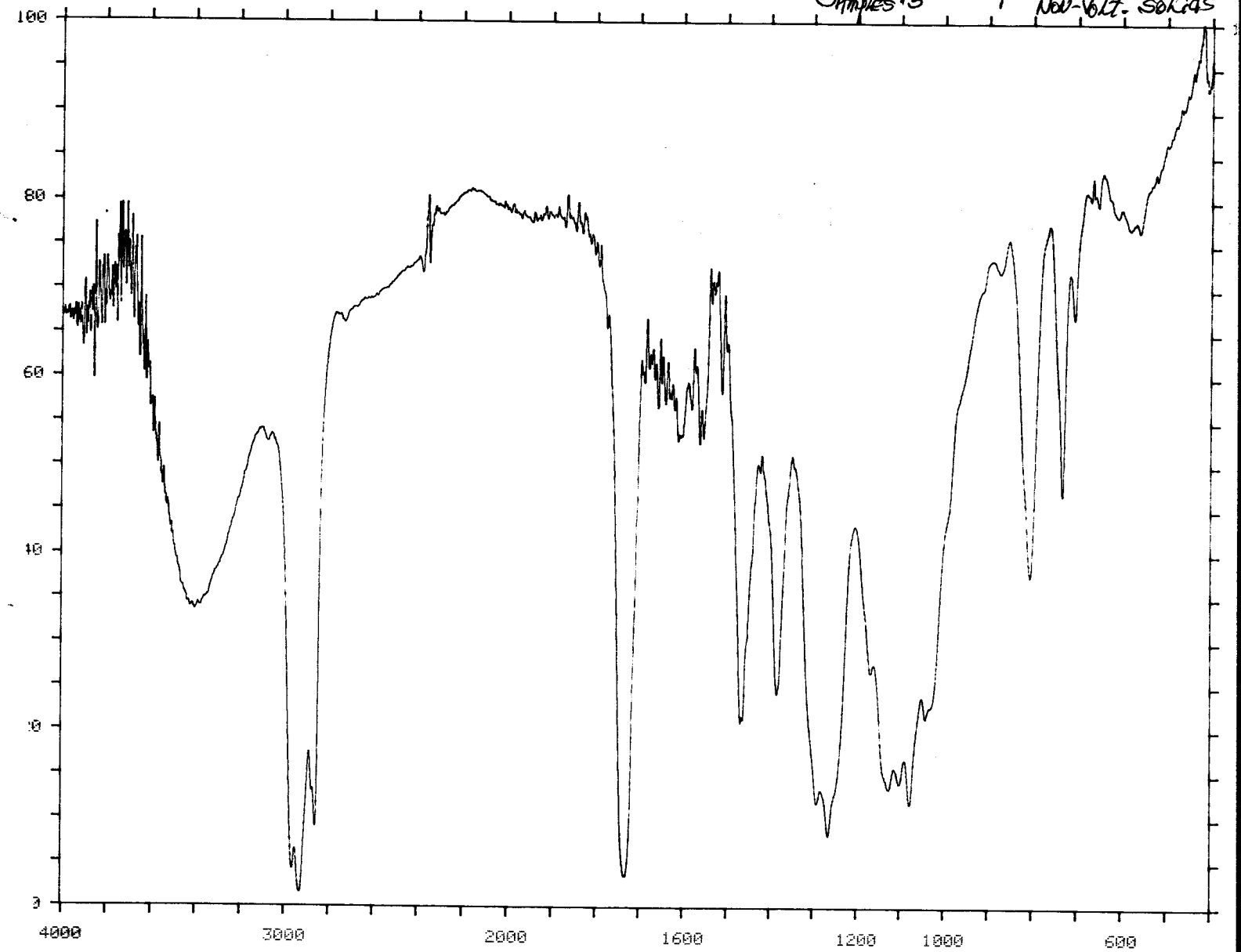
11/23/94 CBI
NON-VOLATILES IN
CONTAM. SOLVENT




11/23/94 - CBI
NV's - SOLVENT (CONTR
NV's - CONTAM. SOLVE
Sample Set #3
100
80
60
40
20
0
3000
2000
1600
1200
1000

11/29/94 CBT

Samples #3 Propanol solvent (Cont
Non-Volt. solids



R. V. [redacted]TZSIMMONS AND ASS(INC.

CHEMICAL ANALYSTS AND CONSULTANTS

1860 Arthur Drive
West Chicago, Illinois 60185

(708) 231-0680
FAX: (708) 231-0811

ANALYSIS REPORT FOR:

CBI TECHNICAL SERVICES
1501 N. Division St.
Plainfield, IL 60544

Attn: Steve Peters

PURCHASE ORDER NO. 12-02-007 Rev.0

DATE 12/6/94

REPORT OF MATERIALS ANALYSIS: Analysis of three propanol solutions for non-volatiles content.
Samples submitted 12/02/94: Virgin alcohol
Alcohol Rinse
Alcohol Wash

METHODS: For both the propanol solvent and the contaminated propanol solution, 100 ml of each liquid was quantitatively oven dried in clean glass vessels.
The non-volatile materials left after the oven drying were analyzed by FTIR spectral analysis on a KBr window for identification and comparison.The ordinate expansion factor (abex) was kept the same for all the spectra except where indicated.
Copies of the FTIR spectra enclosed.

RESULTS:

Non-Volatile Content of the Propanol Solvent

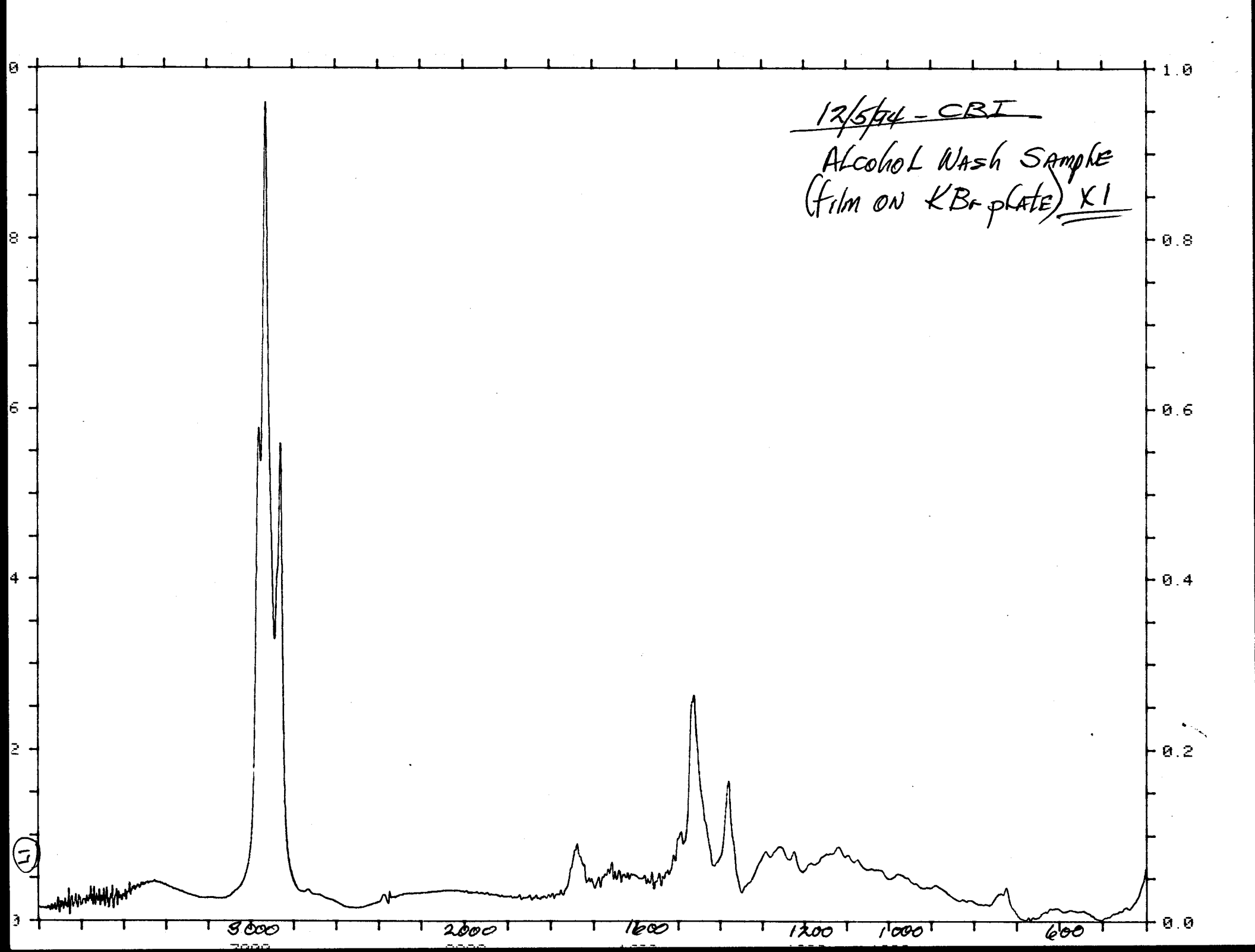
The solvent was found to contain 21. mg/l (26 ppm) of non-volatile matter which is identified as predominantly a a hydrocarbon oil or grease.

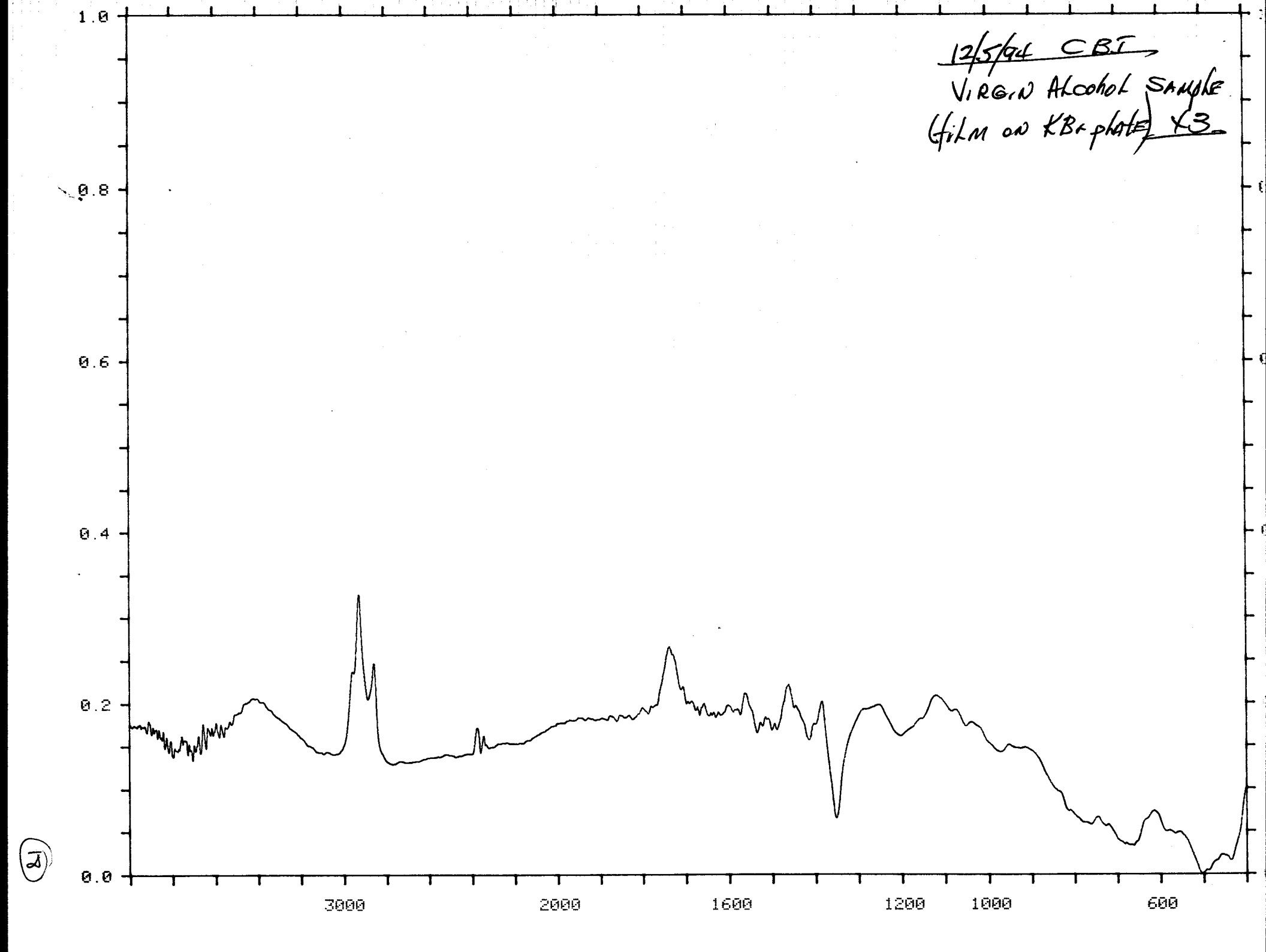
Non-Volatile Content of the Alcohol Rinse.

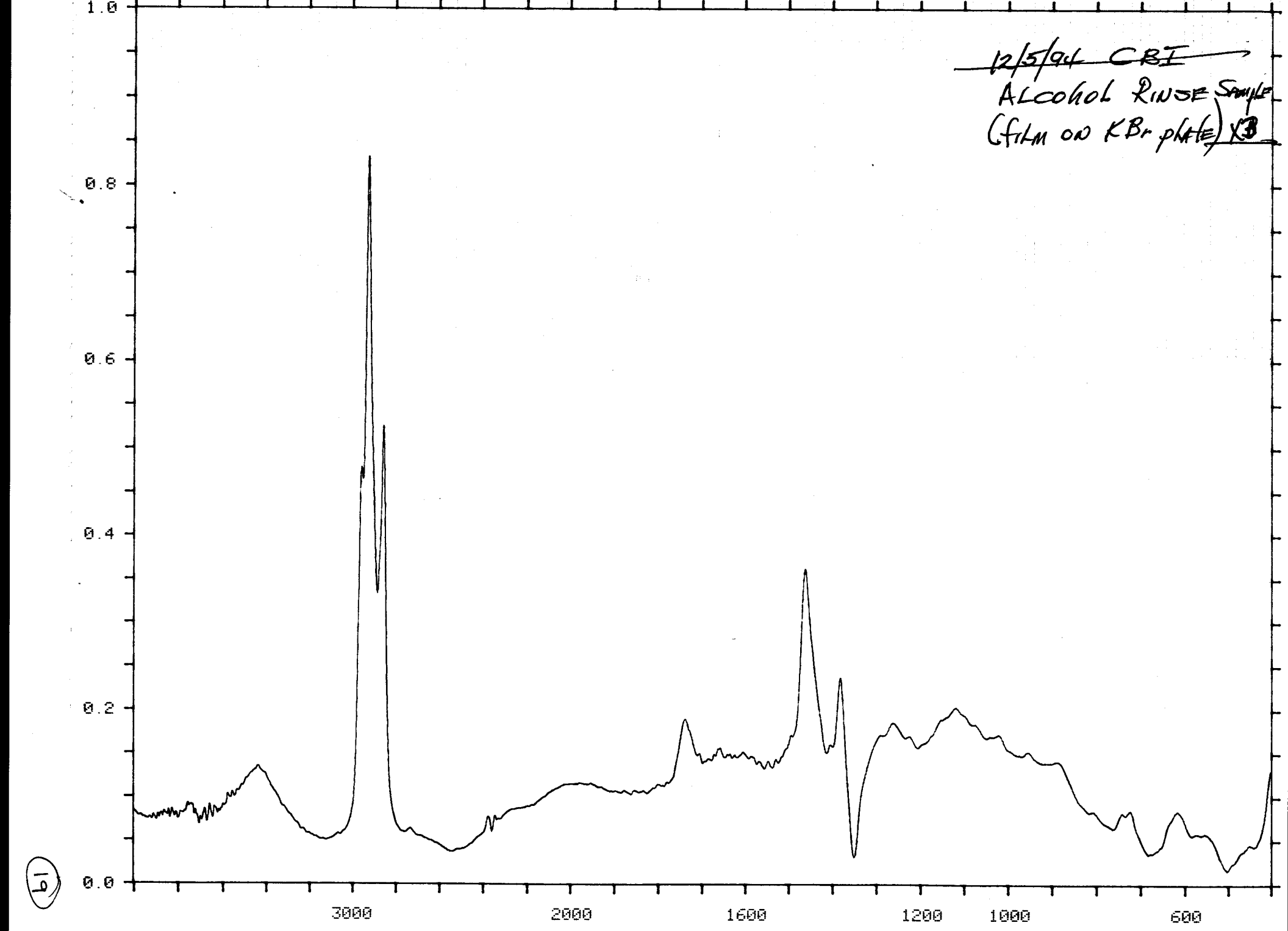
This solution contained 58. mg/l (72.5 ppm) of non-volatile matter.
The non-volatiles here are identified as predominantly a hydrocarbon oil or grease and also contain a smaller amount of an ester oil.

Non-Volatile Content of the Alcohol Wash.

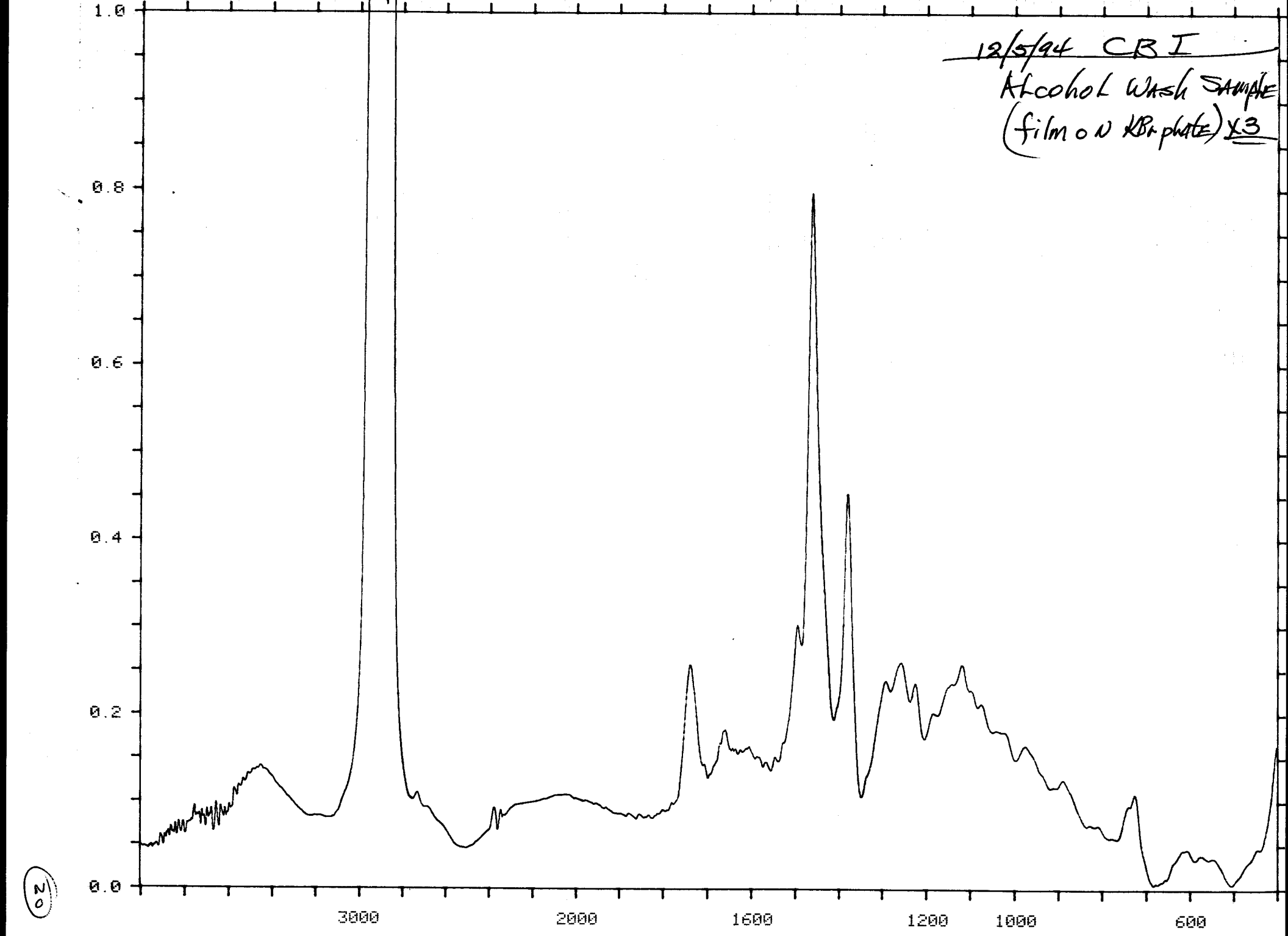
This solution contained 168 mg/l (210 ppm) of non-volatiles.
These appeared to be the same general composition as the rinse solution and are identified as predominantly a hydrocarbon oil or grease with a smaller amount of an ester oil.

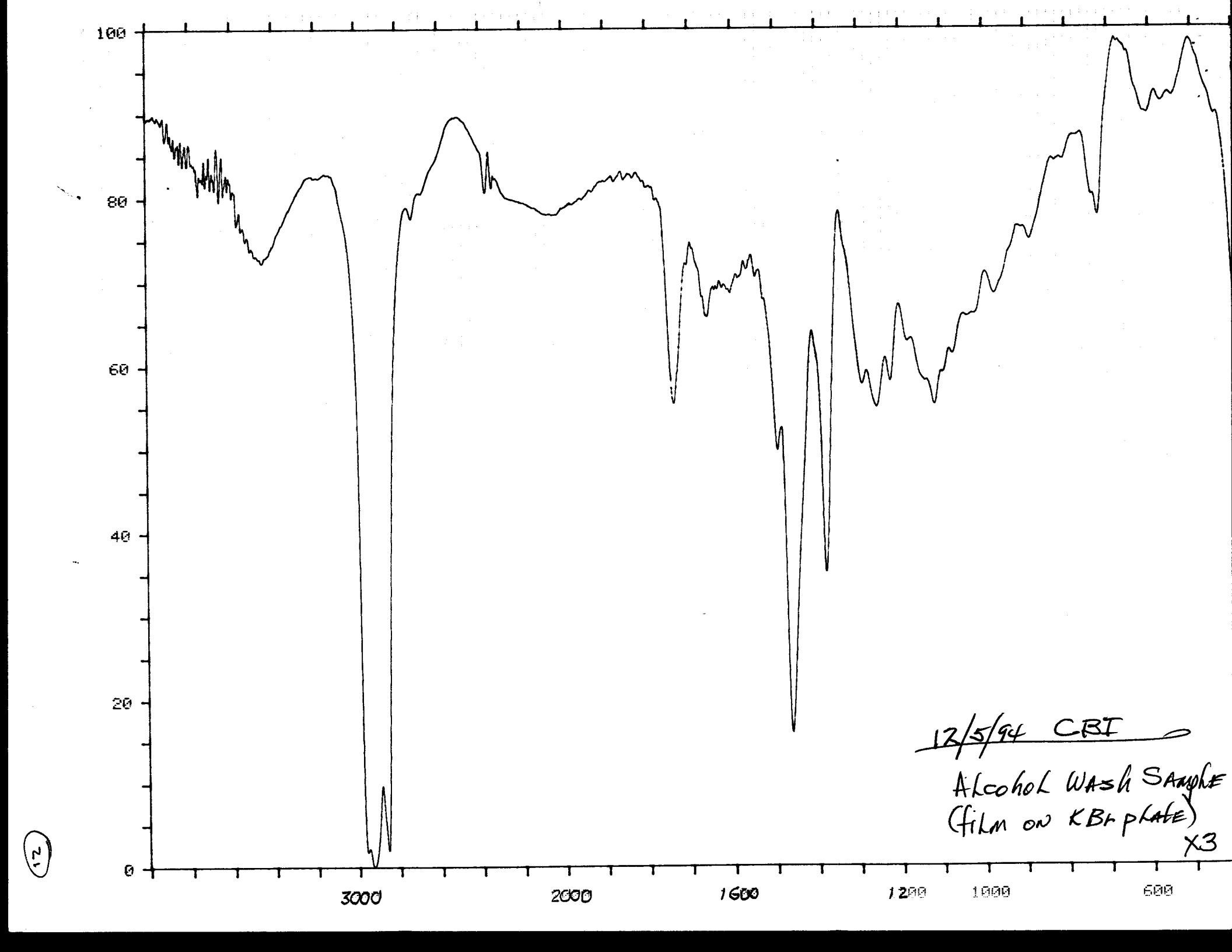

12/5/94 - CBI
Alcohol Wash Sample
(film on KBr plate) X1
1.0
0.8
0.6
0.4
0.2
0.0
3000
2000
1600
1200
1000
600

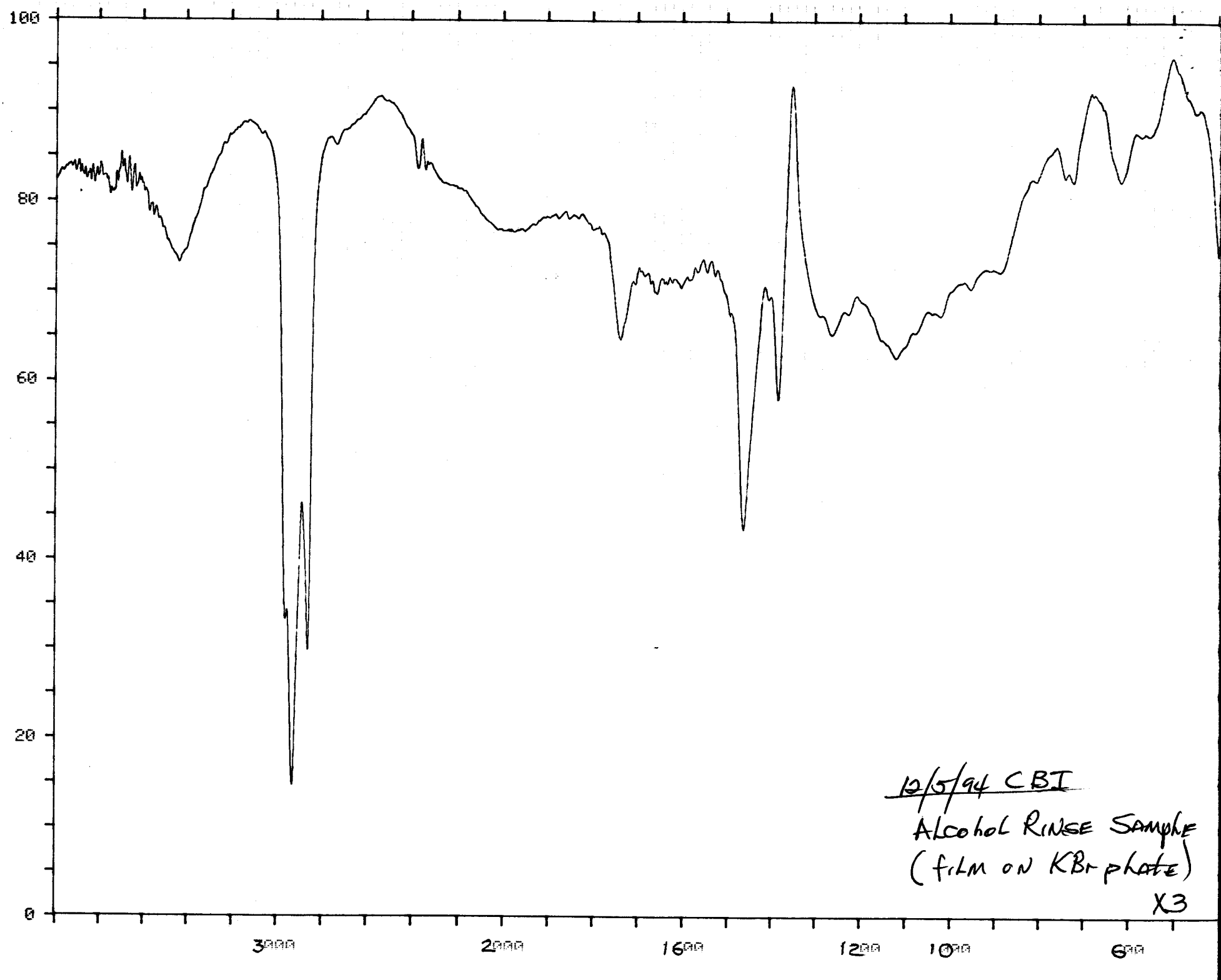

12/5/94 CBI
VIRGIN ALCOHOL SAMPLE
FILM ON KBr plate X3
1.0
0.8
0.6
0.4
0.2
0.0
3000
2000
1600
1200
1000
600

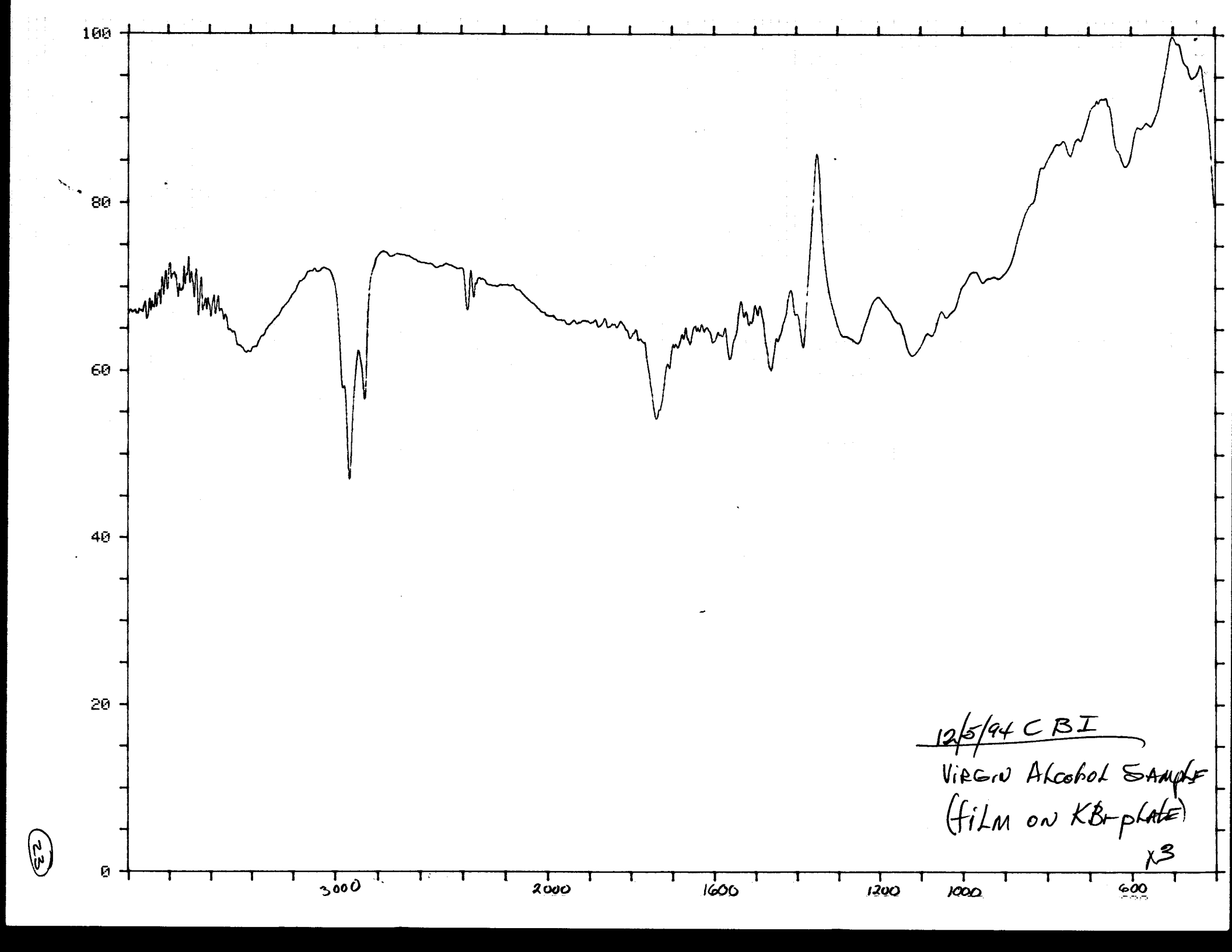

12/5/94 CBI
ALCOHOL RINSE SAMPLE
(FILM ON KBr plate) X3
1.0
0.8
0.6
0.4
0.2
0.0
3000
2000
1600
1200
1000
600

(19)


12/5/94 CRI
Alcohol Wash Sample
(film on KBr plate) x3
1.0
0.8
0.6
0.4
0.2
0.0
3000
2000
1600
1200
1000
600
NO


100
80
60
40
20
0
3000
2000
1600
1200
1000
800
12/5/94 CBI
Alcohol Wash Sample
(film on KBr plate)
X3
12


100
80
60
40
20
0
3000
2000
1600
1200
1000
800
12/5/94 CBI
Alcohol Rinse Sample
(film on KBr plate)
X3


100
80
60
40
20
0
3000
2000
1600
1200
1000
600
12/5/94 CBI
VIRGIN ALCOHOL SAMPLE
(FILM ON KBr PLATE)
X3
23

R. V. FITZSIMMONS AND ASSOC. INC.

CHEMICAL ANALYSTS AND CONSULTANTS

1860 Arthur Drive
West Chicago, Illinois 60185

(708) 231-0680
FAX: (708) 231-0811

ANALYSIS REPORT FOR:

CBI TECHNICAL SERVICES
1501 N. Division St.
Plainfield, IL 60544

Attn: Steve Peters

PURCHASE ORDER NO 12-005 Rev.0

DATE 12/ 14/ 94

REPORT OF MATERIALS ANALYSIS: Analysis of seven samples of 2-propanol used in cleaning tube 22A.
Samples submitted 12/12/94: Cleaning assessment samples 1A,2A,3A & 4A
Wash & Rinse samples: Wash, Rinse & Control

METHODS: For both the propanol solvent and the contaminated propanol solution, 100 ml or 200 ml of each liquid was quantitatively oven dried in clean glass vessels.
The non-volatile materials left after the oven drying were analyzed by FTIR spectral analysis on a KBr window for identification and comparison.The ordinate expansion factor (abex) is the same for all spectra except where indicated.
Copies of the FTIR spectra enclosed.

RESULTS:

Cleaning Assessment Samples

Control (virgin propanol) - The non-volatile (NV) residue was 7.0 mg/l and found to be predominantly a hydrocarbon oil or grease with a small amount of ester type oil.

Sample 1A - The NV residue was 14.5 mg/l and found to be a mixture of hydrocarbon oil, ester oil and other components.

Sample 2A - The NV residue was 8.5 mg/l and found to be a mixture of hydrocarbon oil, ester oil and other components.

Sample 3A - The NV residue was 5.5mg/l and found to be predominantly a hydrocarbon oil similar to the NV content of the virgin propanol of the control.

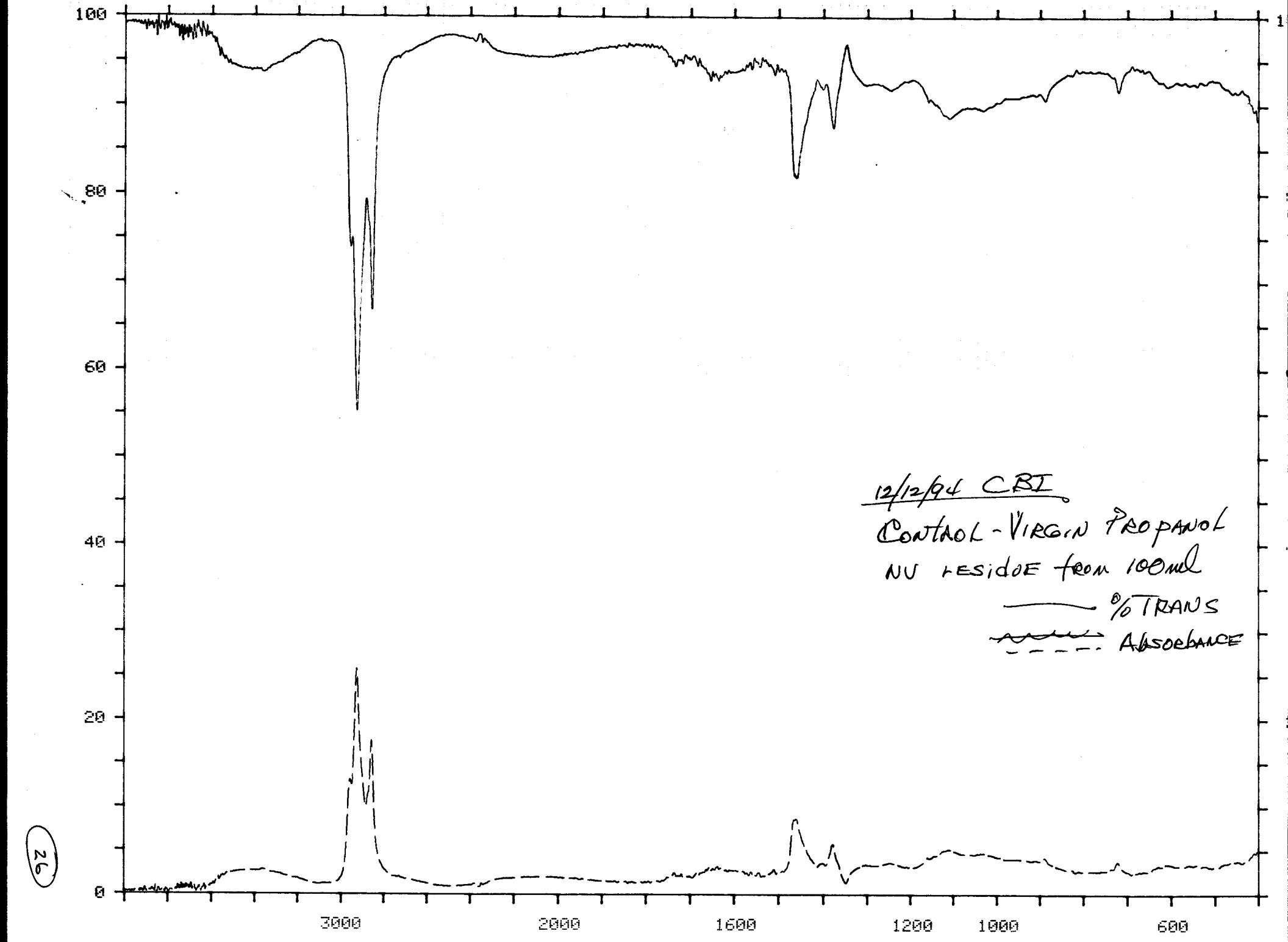
Sample 4A - The NV residue was 7.5 mg/l and found to be predominantly a hydrocarbon oil with smaller amounts of an ester oil similar to the NV content of the control propanol sample.

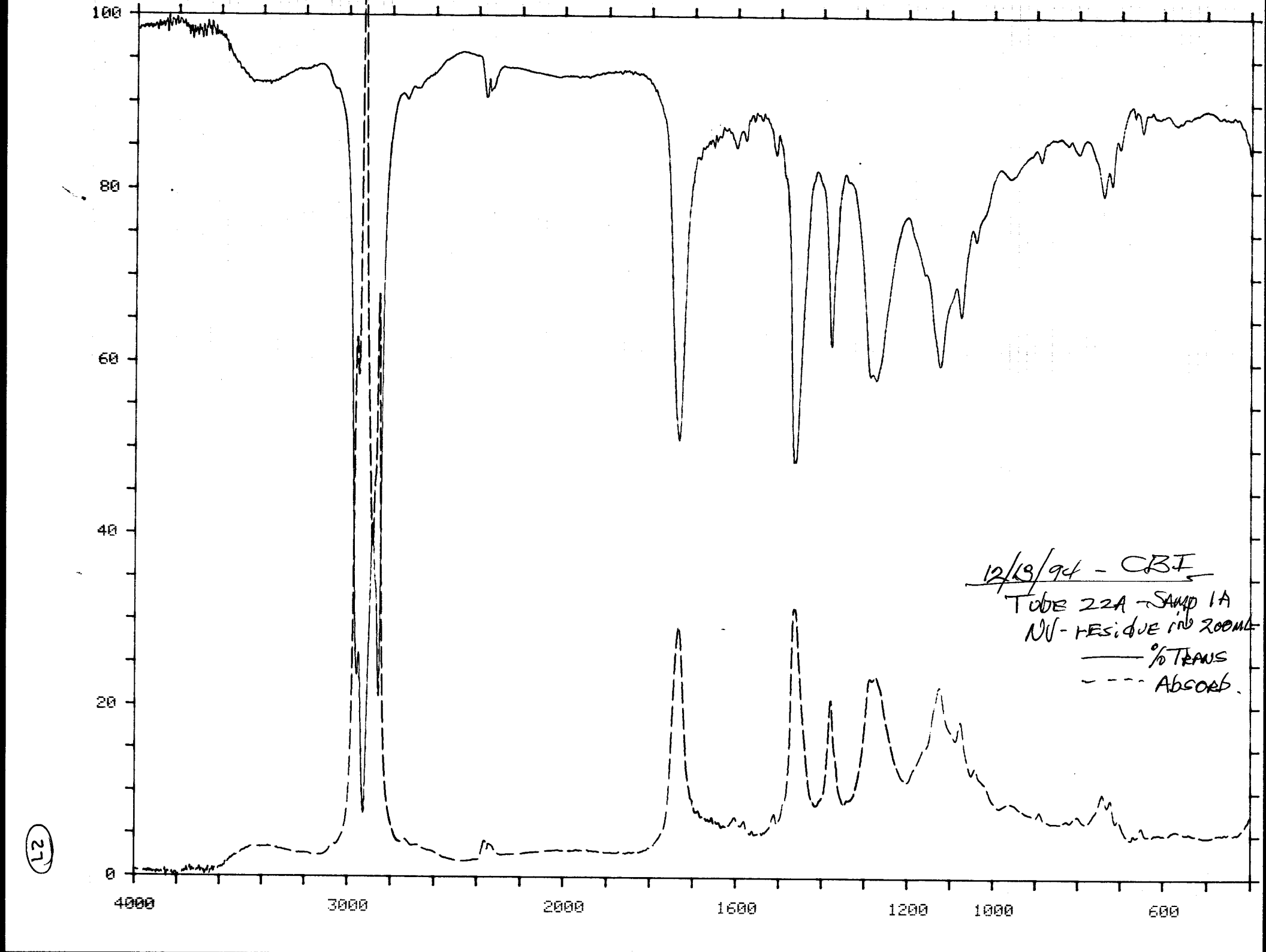
Wash & Rinse samples from 22A

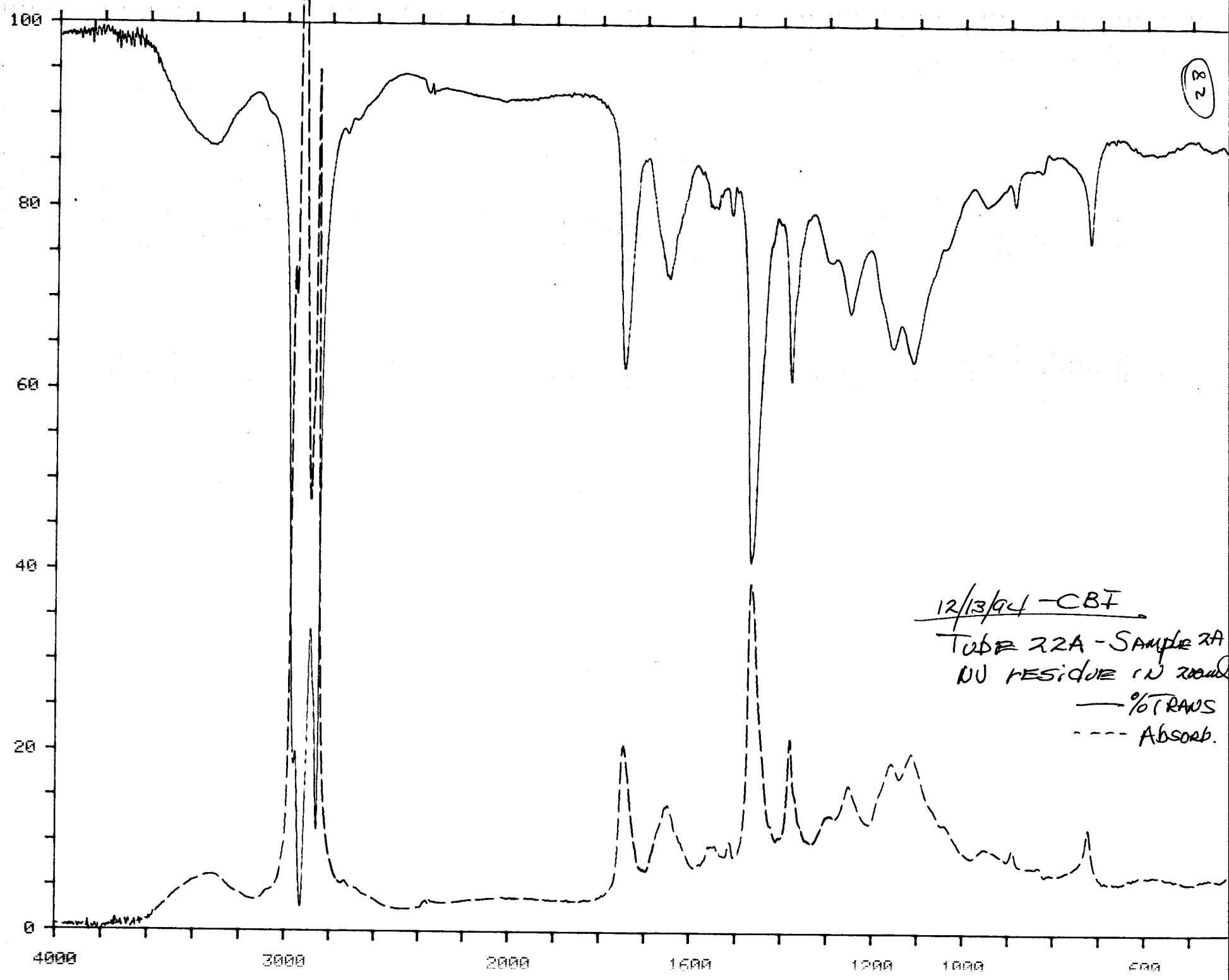
Virgin Propanol (Control) - The NV residue was 13.0mg/l and was found to be a hydrocarbon oil or grease.

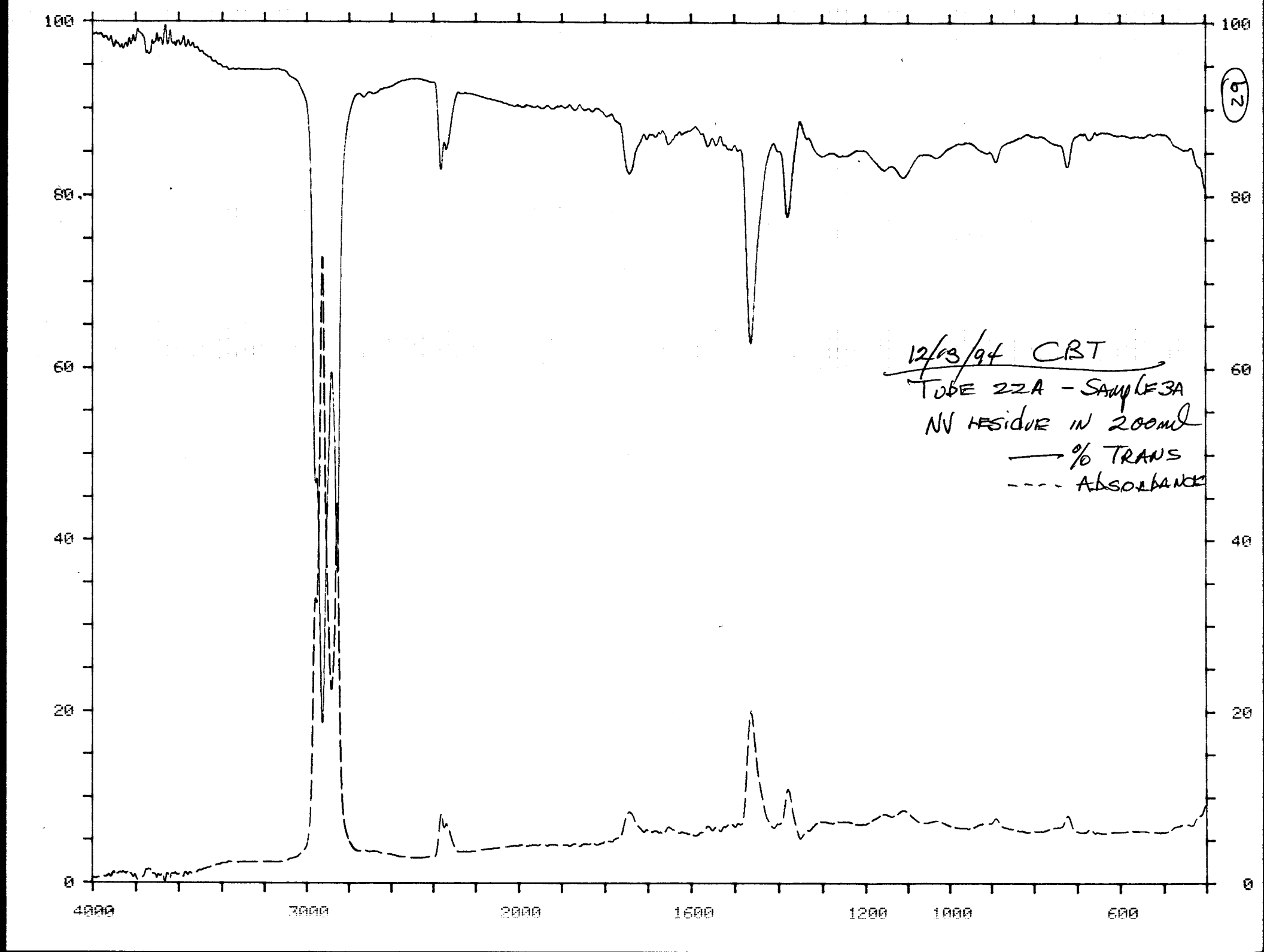
Tube 22A, Propanol Rinse - The NV residue was 28.0mg/l and was found to be predominantly a hydrocarbon oil with a small amount of ester type oil, similar to the control sample.

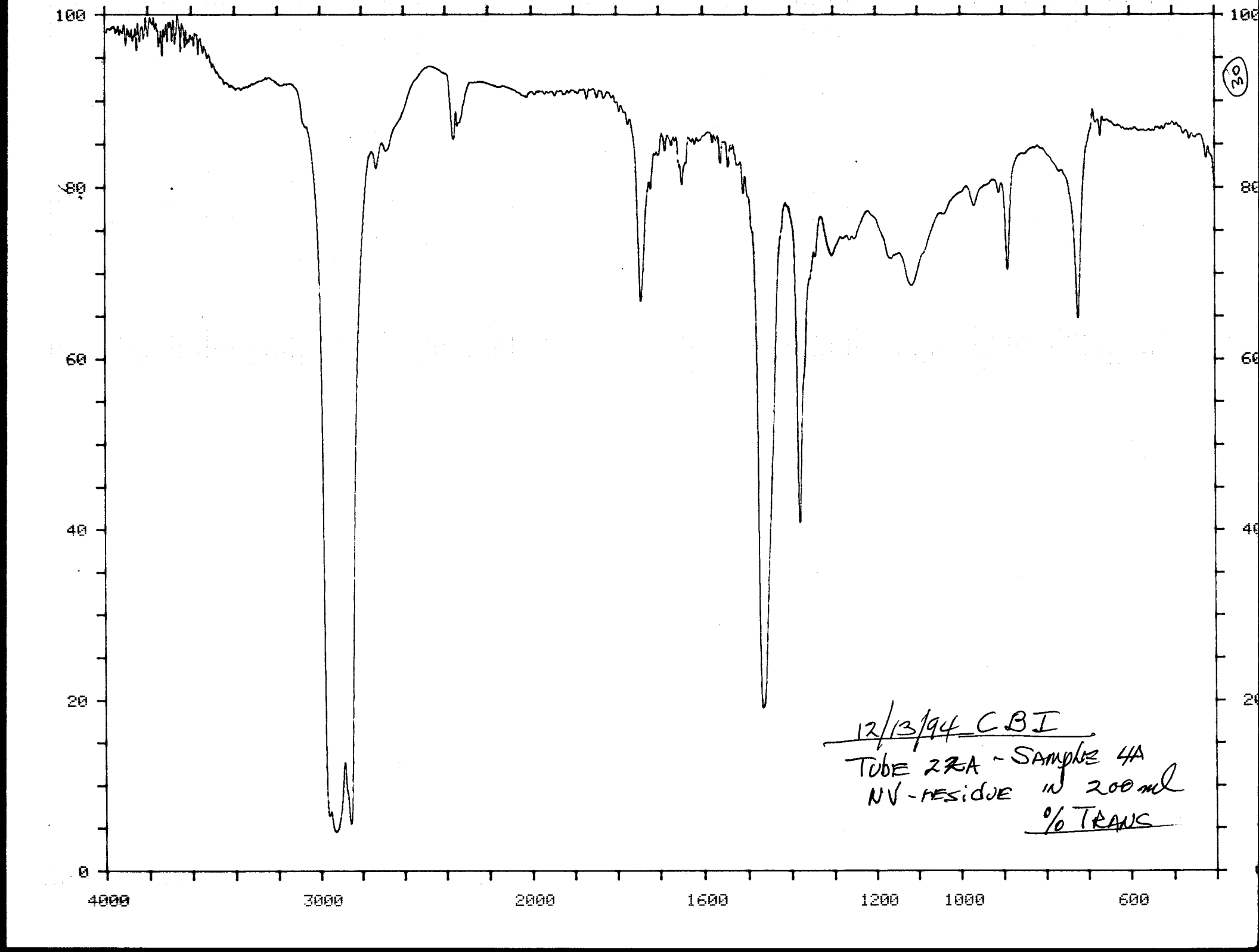
Tube 22A, Propanol Wash - The NV residue was 43.5mg/l and found to be a complex mixture containing hydrocarbon oil, ester type oil and other components.

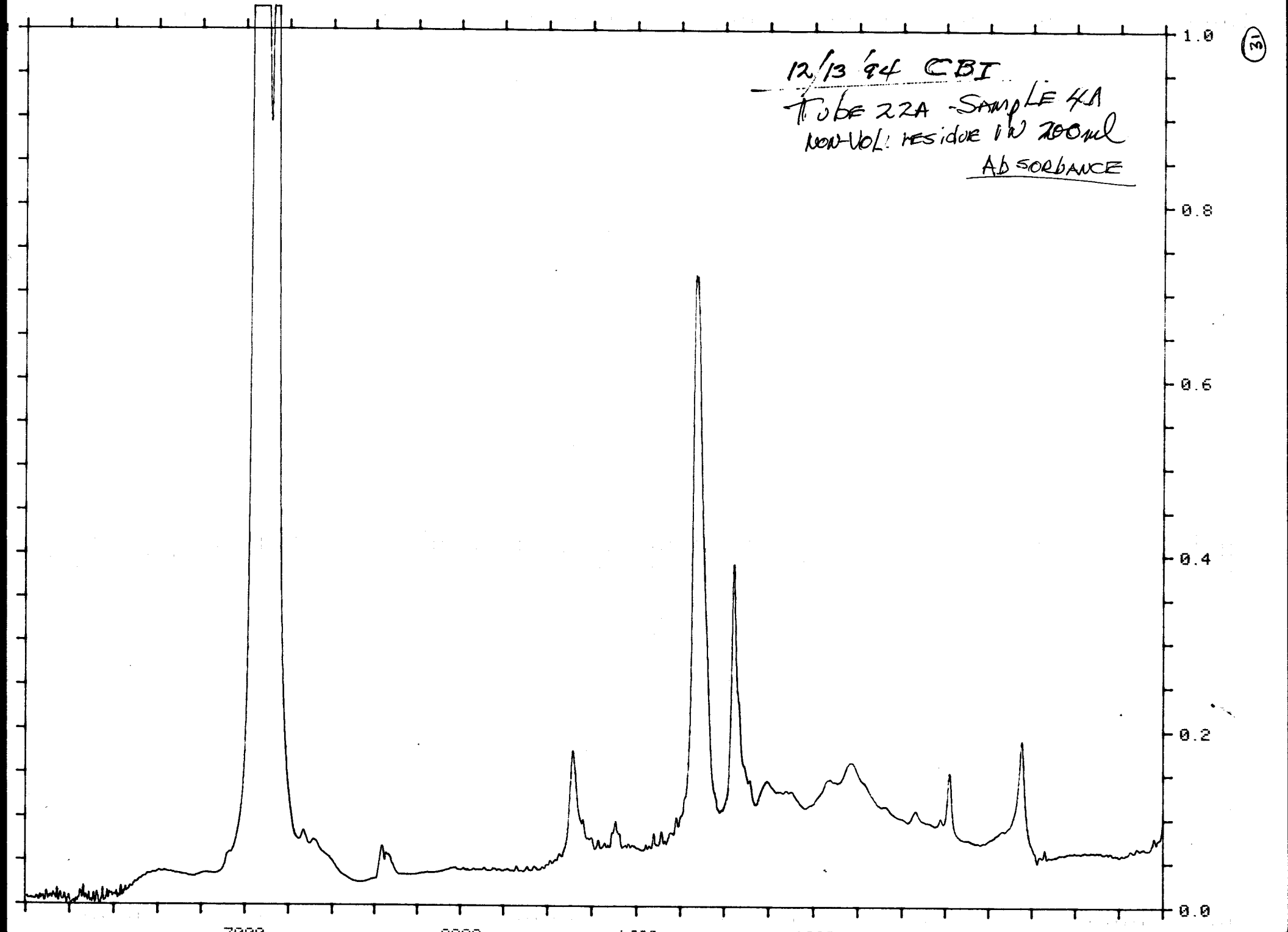

100
80
60
40
20
0
3000
2000
1600
1200
1000
600
12/12/94 CBI
CONTROL - VIRGIN PROPANOL
NU RESIDUE FROM 100ml
% TRANS
ABSORBANCE

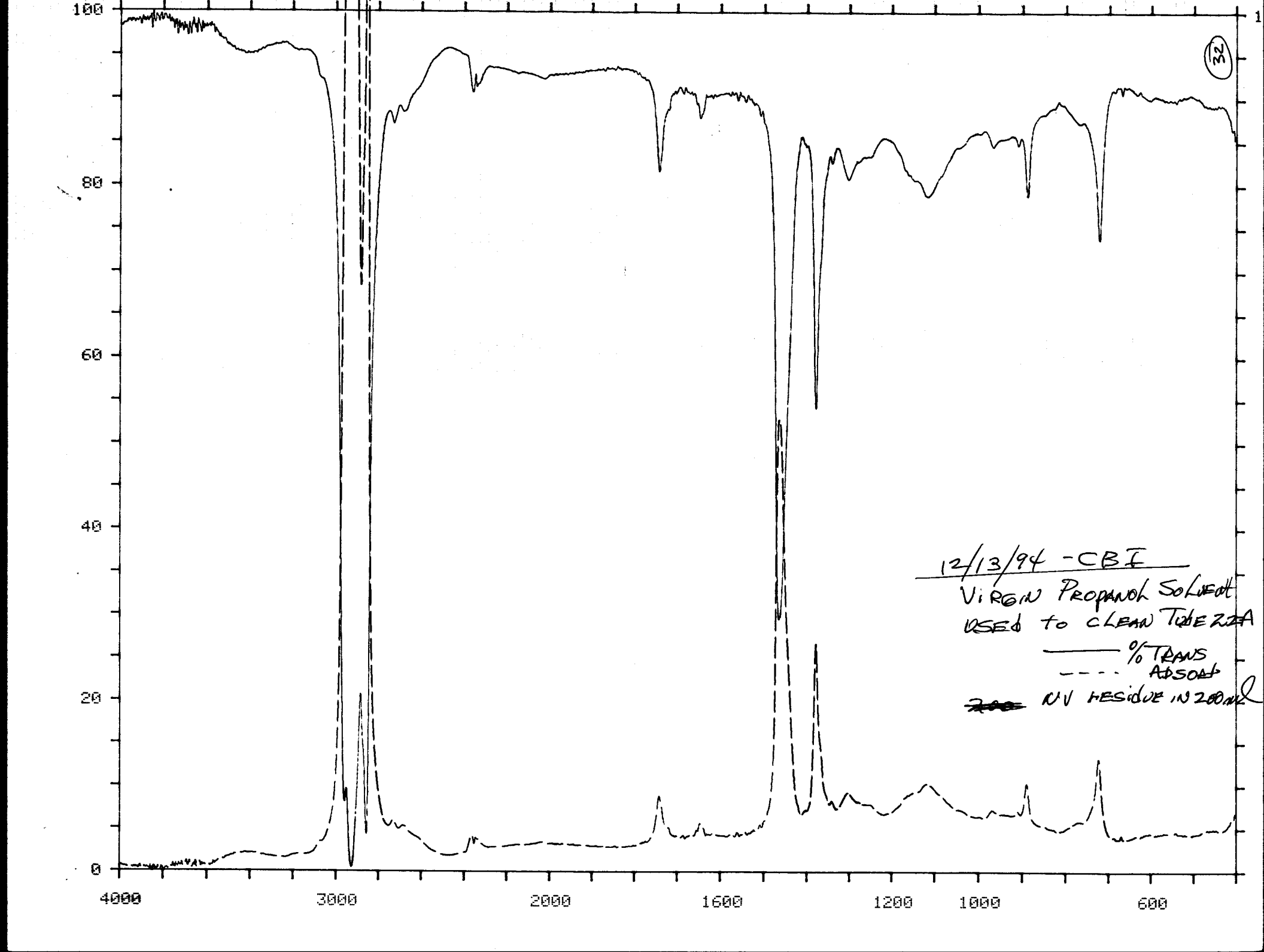

100
80
60
40
20
0
4000
3000
2000
1600
1200
1000
600
12/19/94 - CBI
TUBE 22A - SAMP 1A
NV - RESIDUE IN 200ML
% TRANS
ABSORB.

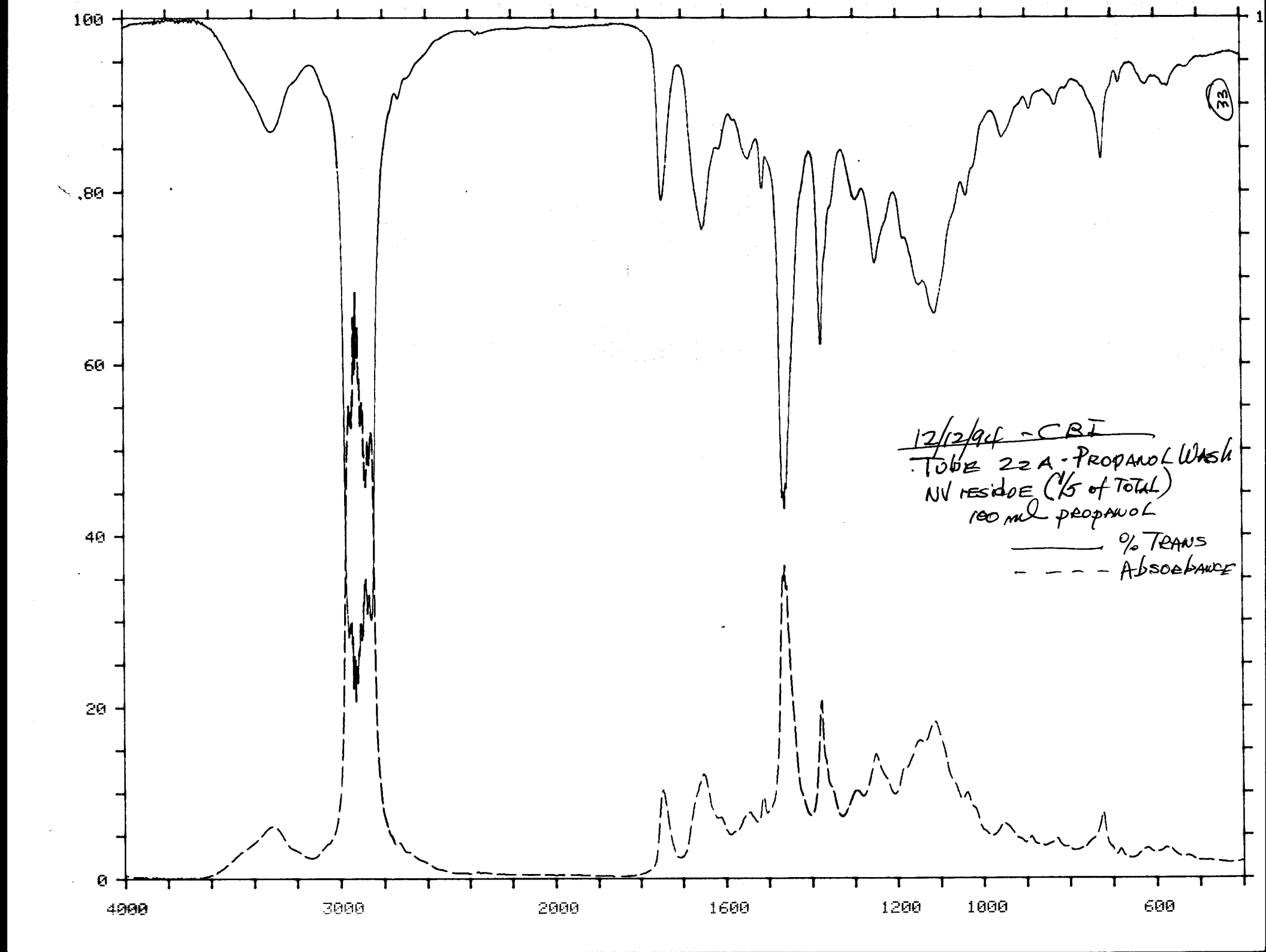

100
80
60
40
20
0
4000
3000
2000
1600
1200
1000
28
12/13/94 -CBT
TUBE 22A - SAMPLE 2A
NV RESIDUE IN 200mL
—%TRANS
---- ABSORB.

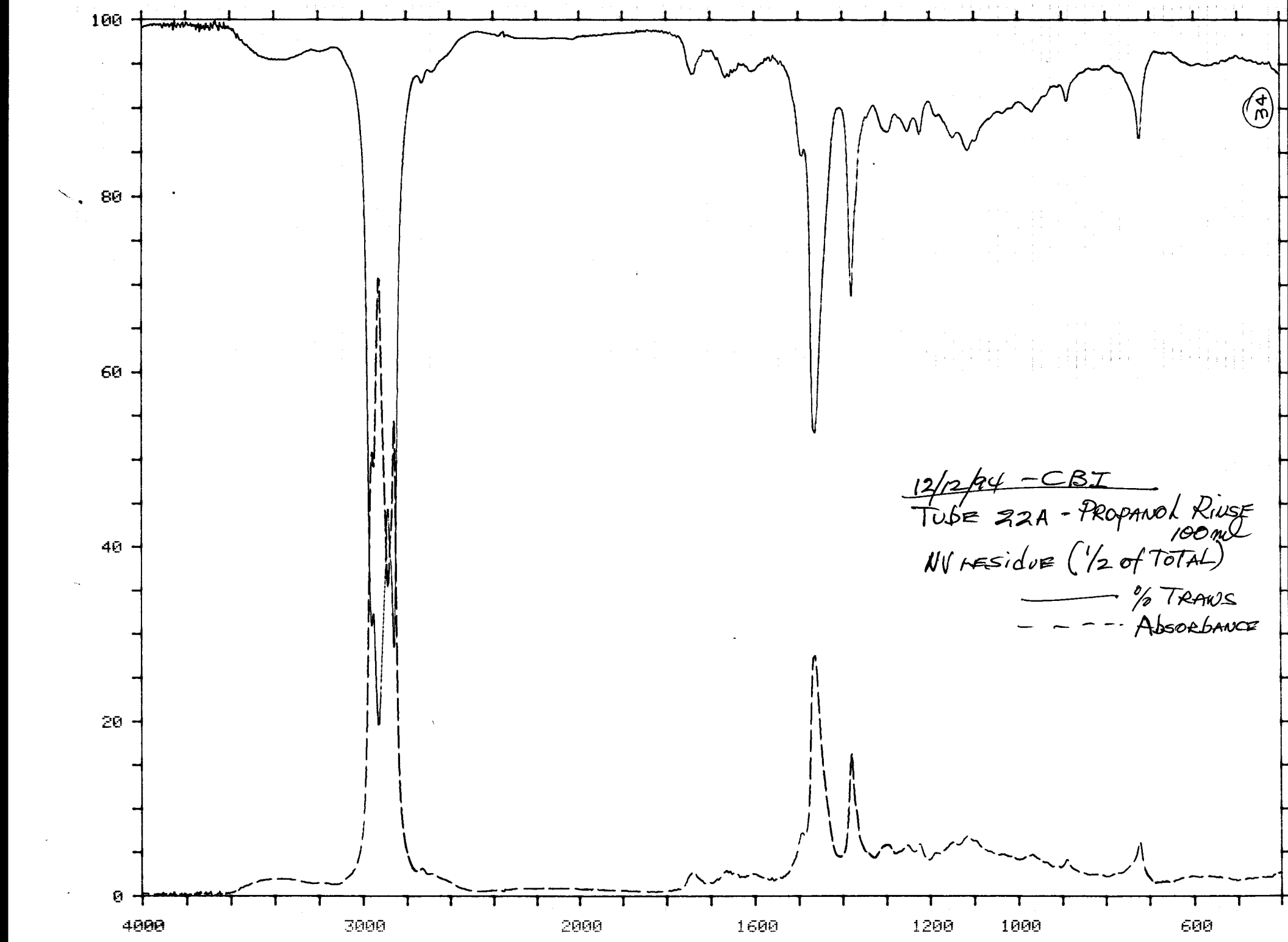

100
80
60
40
20
0
4000
3000
2000
1600
1200
1000
800
62
12/03/94 CBT
TUBE 22A - SAMPLE 3A
NV RESIDUE IN 200ml
% TRANS
ABSORBANCE


100
80
60
40
20
0
4000
3000
2000
1600
1200
1000
600
12/13/94 CBI
TUBE 22A - SAMPLE 4A
NV-RESIDUE IN 200 ml
% TRANS


12/13 '84 CBI
TUBE 22A - SAMPLE 4A
NON-VOL: RESIDUE IN 200ml
ABSORBANCE
1.0
0.8
0.6
0.4
0.2
0.0


100
80
60
40
20
0
4000
3000
2000
1600
1200
1000
600
32
12/13/94 -CBE
VIRGIN PROPANOL SOLVENT
USED TO CLEAN TUBE 2124
% TRANS
ABSORB
NV RESIDUE IN 200ml


100
80
60
40
20
0
4000
3000
2000
1600
1200
1000
600
33
12/12/94 - CBI
TUBE 22A - PROPANOL WASH
NV RESIDUE (% of TOTAL)
100 ml PROPANOL
% TRANS
ABSORBANCE


100
80
60
40
20
0
4000
3000
2000
1600
1200
1000
600
34
12/12/94 - CBI
TUBE 22A - PROPANOL RINSE 100 ml
NV RESIDUE (1/2 of TOTAL)
% TRANS
ABSORBANCE

R. V. FITZSIMMONS AND ASSOC. INC.

CHEMICAL ANALYSTS AND CONSULTANTS

1860 Arthur Drive
West Chicago, Illinois 60185

(708) 231-0680
FAX: (708) 231-0811

ANALYSIS REPORT FOR:

CBI TECHNICAL SERVICES
1501 N. Division St.
Plainfield, IL 60544

Attn: Steve Peters

PURCHASE ORDER NO. 12-12-005 Rev.0

DATE 12/15/94

REPORT OF MATERIALS ANALYSIS: Analysis of seven samples of 2-propanol used in cleaning tube 22B.
Samples submitted 12/13/94: Cleaning assessment samples 1A,2A,3A & 4A
Wash & Rinse samples: Prop. Rinse & Wash

METHODS: For both the propanol solvent and the contaminated propanol solution, 100 ml of each liquid was quantitatively oven dried in clean glass vessels.
The non-volatile materials left after the oven drying were analyzed by FTIR spectral analysis on a KBr window for identification and comparison.The ordinate expansion factor (abex) is the same for all spectra except where indicated.
Copies of the FTIR spectra enclosed.

RESULTS:

Cleaning Assessment Samples for Tube 22B

Control (virgin propanol) - The non-volatile (NV) residue was 6.0 mg/l and found to be predominantly a hydrocarbon oil or grease.

Sample 1A - The NV residue was 9.0 mg/l and found to be a mixture of hydrocarbon oil, ester oil and other components.

Sample 2A - The NV residue was 8.0 mg/l and found to be a mixture of hydrocarbon oil, ester oil.

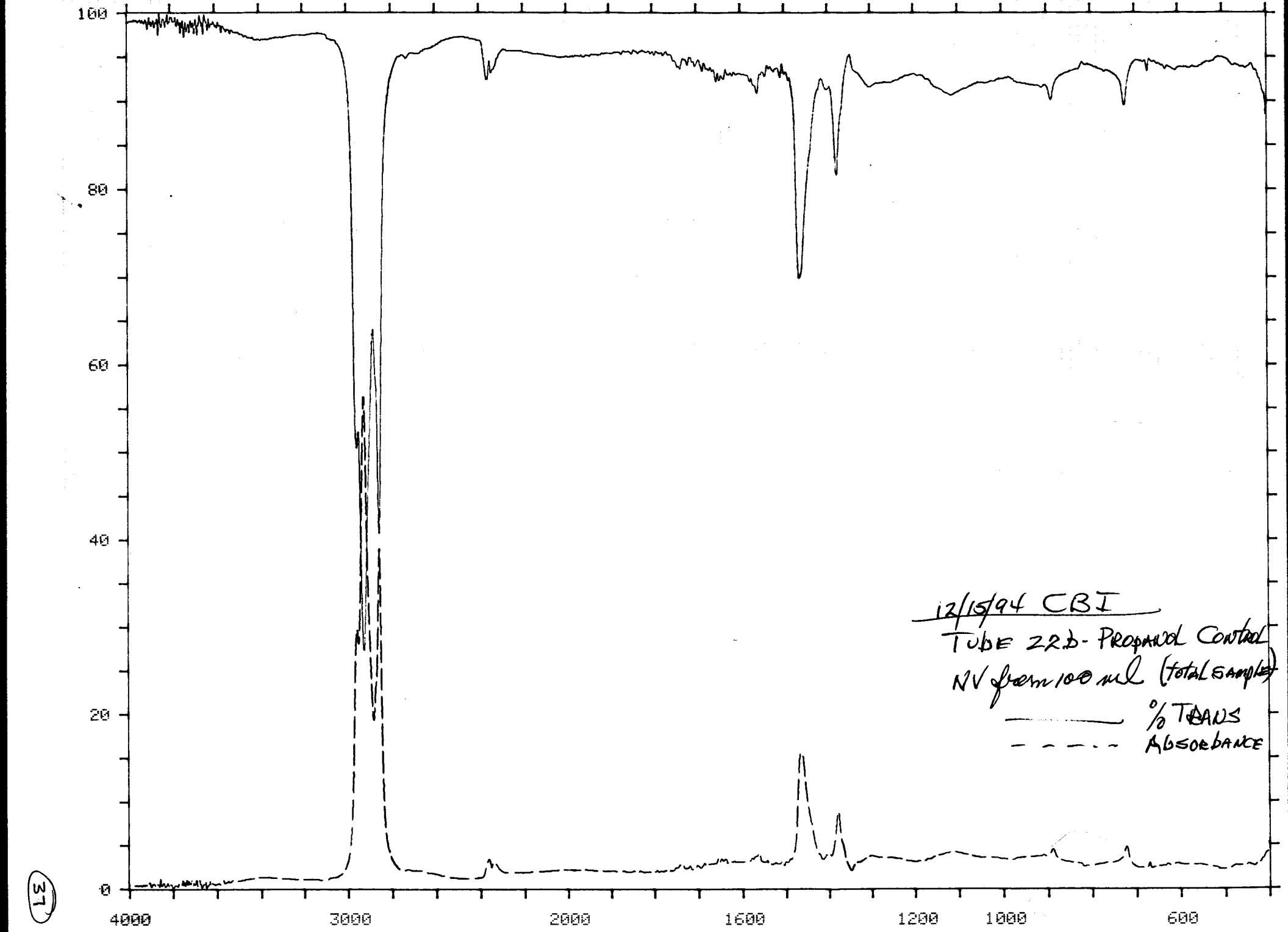
Sample 3A - The NV residue was 2.5mg/l and found to be predominantly a hydrocarbon oil similar to the NV content of the virgin propanol of the control.

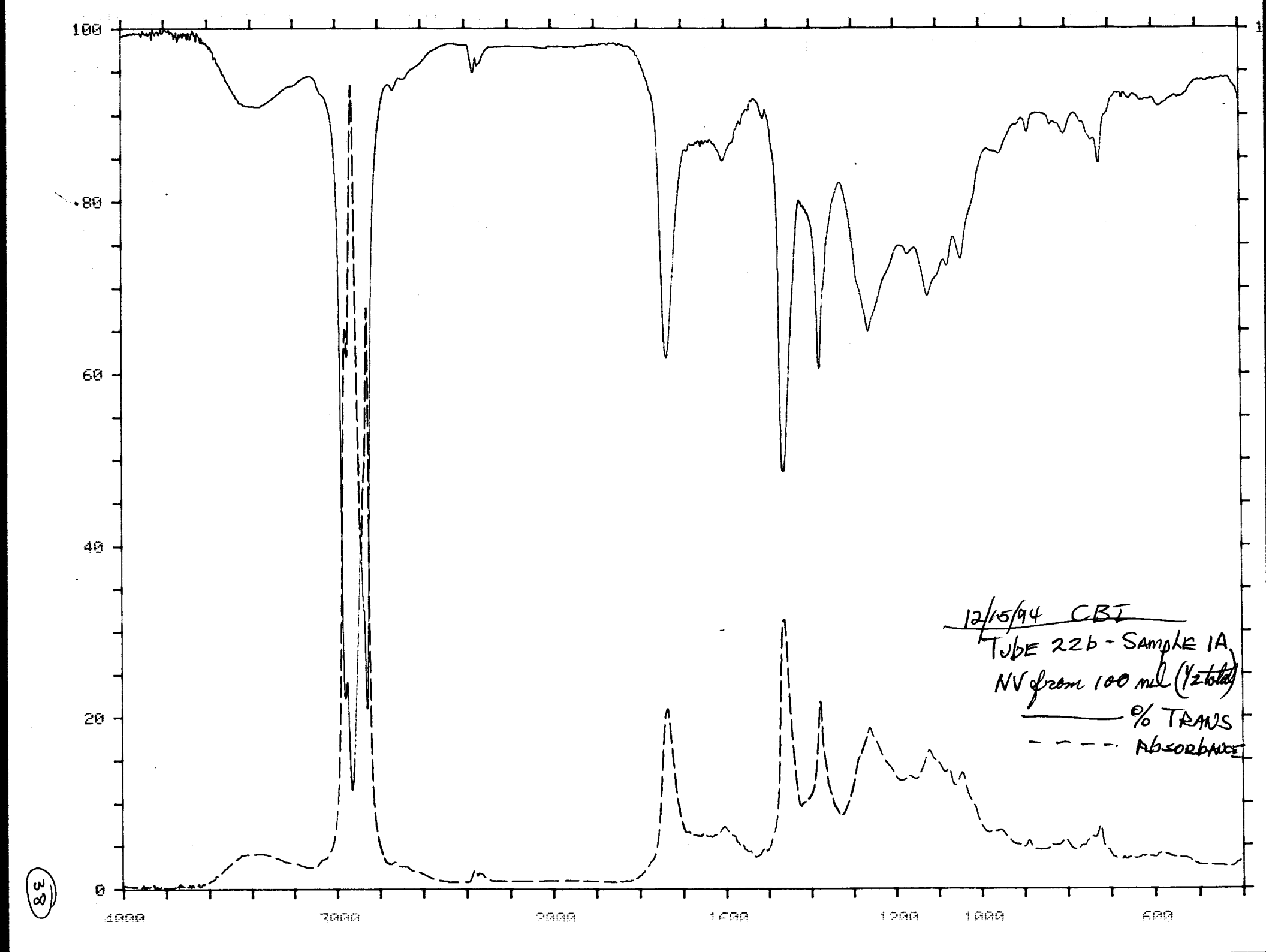
Sample 4A - The NV residue was 2.0 mg/l and found to be predominantly a hydrocarbon oil similar to the NV content of the virgin propanol of the control. content of the control propanol sample.

Wash & Rinse samples from 22B

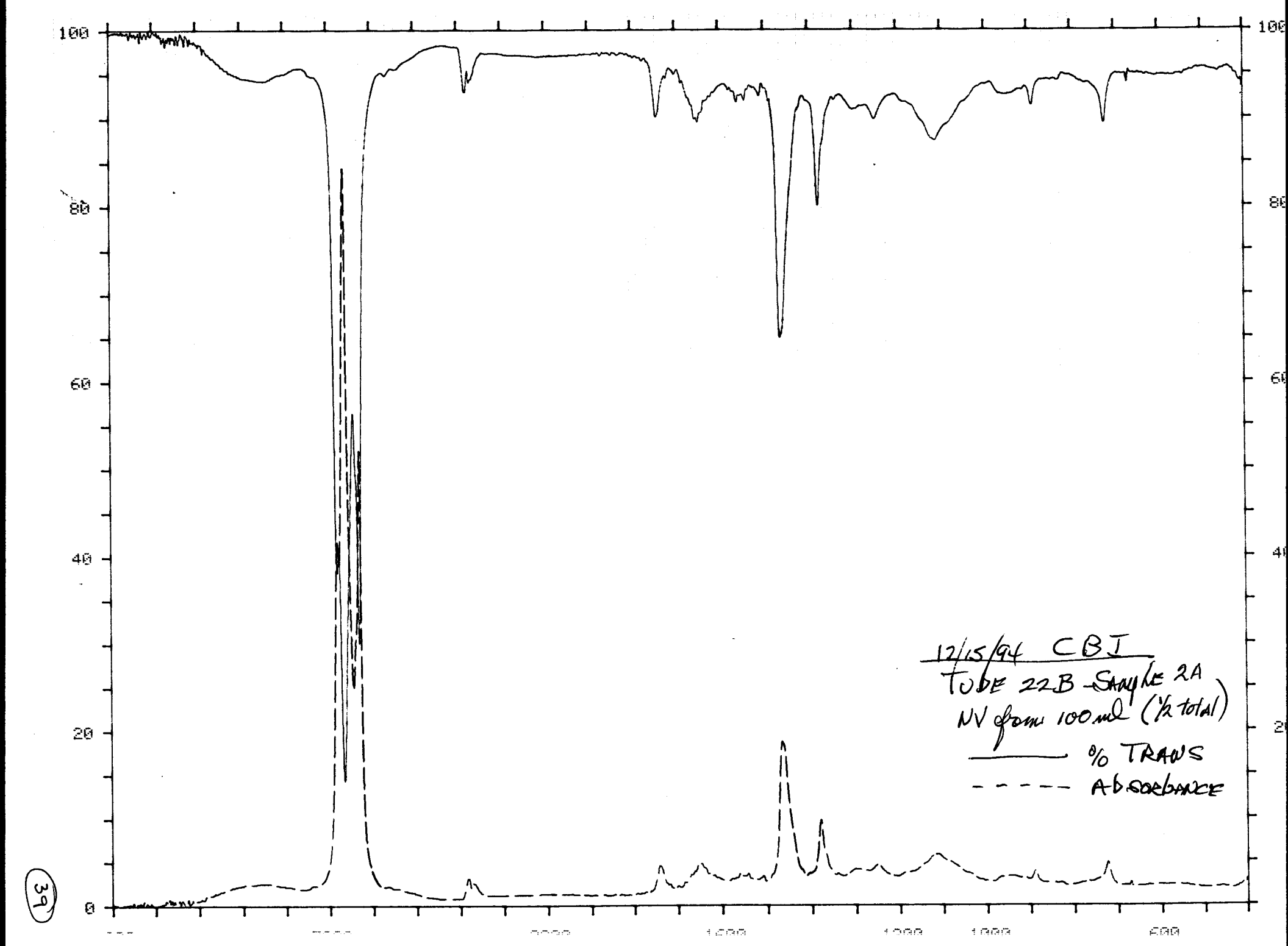
Tube 22A, Propanol Rinse - The NV residue was 18.0mg/l and was found to be predominantly a hydrocarbon oil with a small amount of ester type oil.

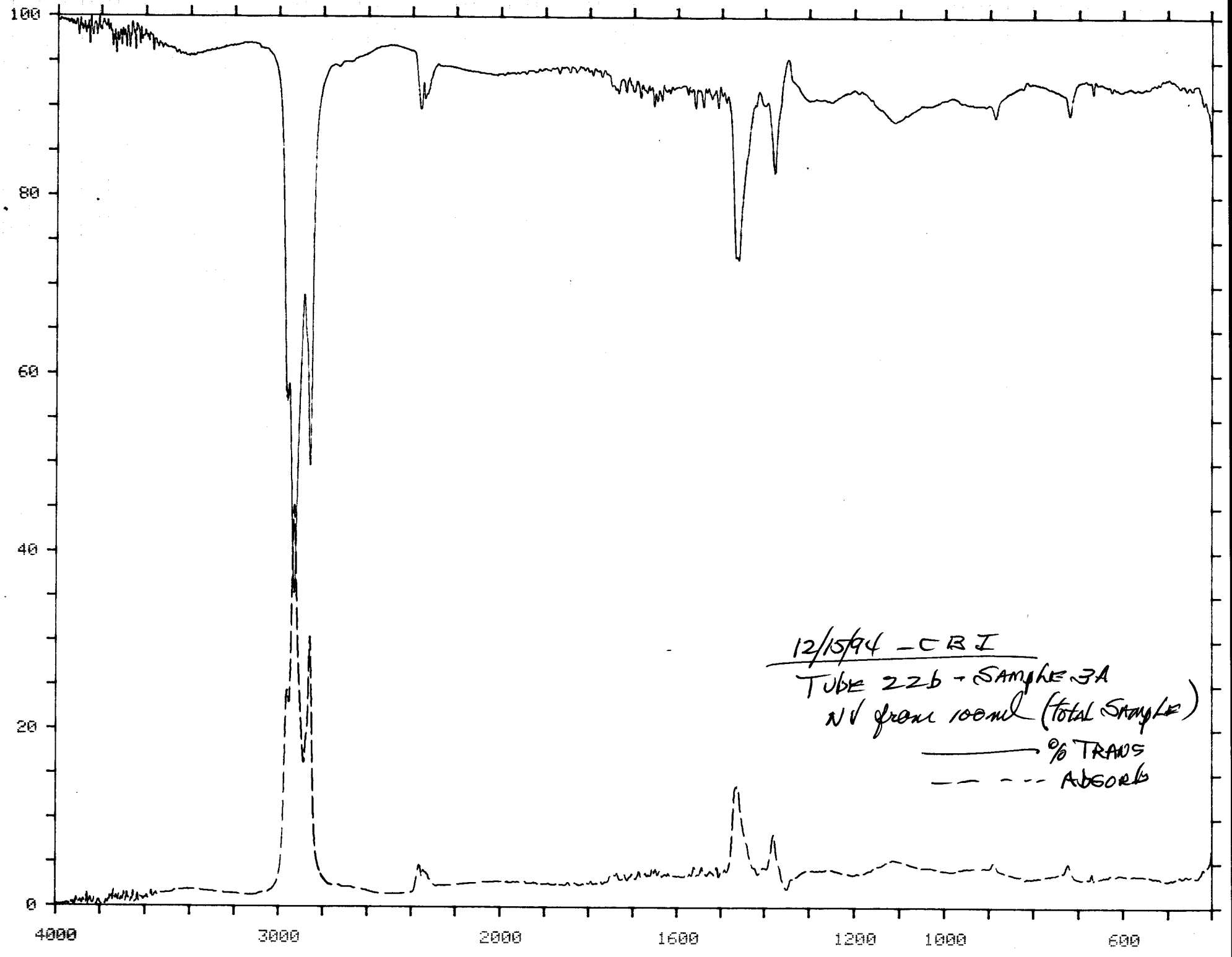
Tube 22A, Propanol Wash - The NV residue was 47.5mg/l and found to be a complex mixture containing hydrocarbon oil, ester type oil and other components.


100
80
60
40
20
0
4000
3000
2000
1600
1200
1000
600
12/15/94 CBI
TUBE 22D - PROPANOL CONTROL
NV from 100 ml (total sample)
% TRANS
ABSORBANCE

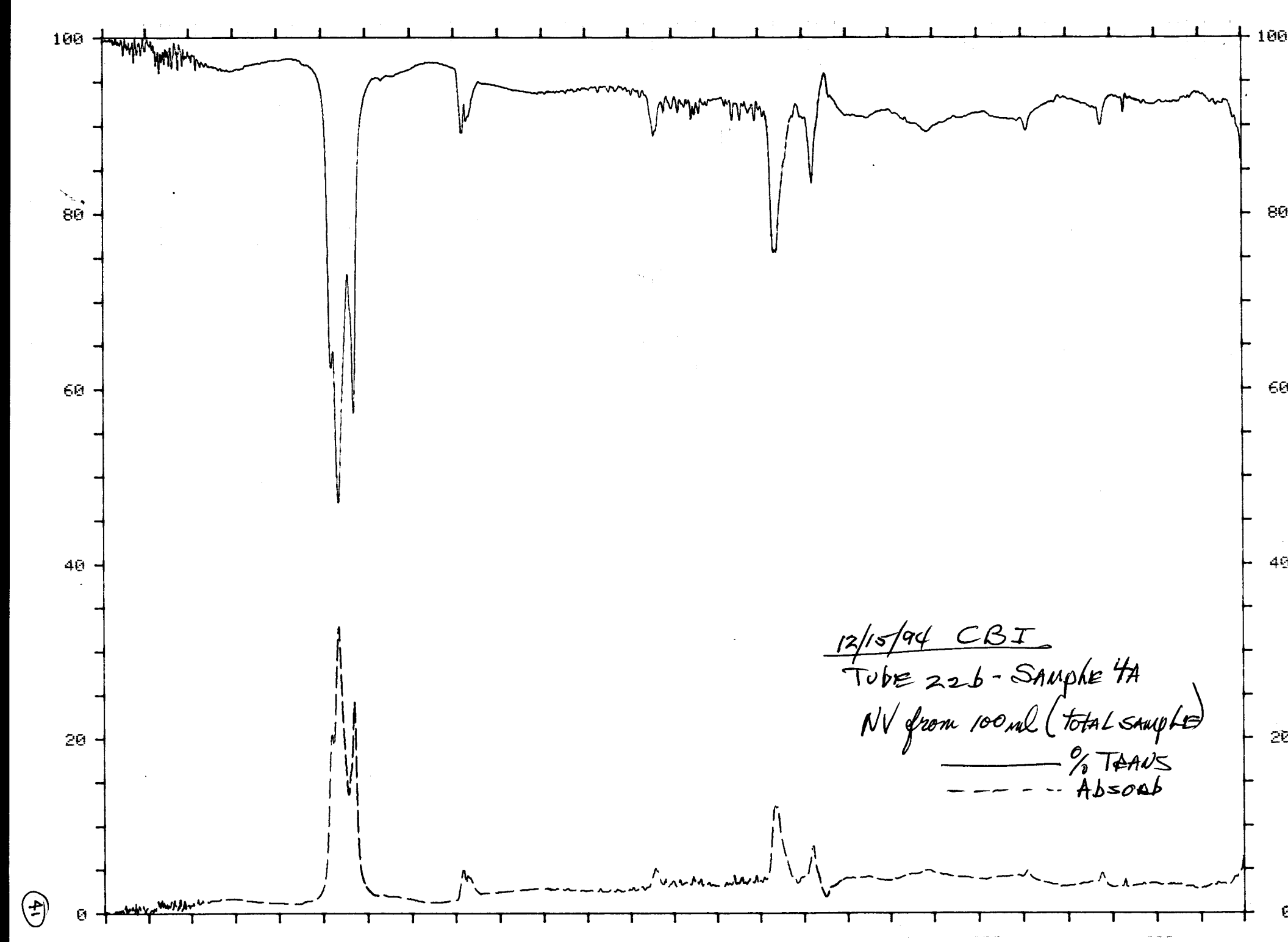

100
80
60
40
20
0
4000
3000
2000
1500
1200
1000
600
12/15/94 CBI
TUBE 22b - SAMPLE 1A
NV from 100 ml (½ total)
% TRANS
ABSORBANCE

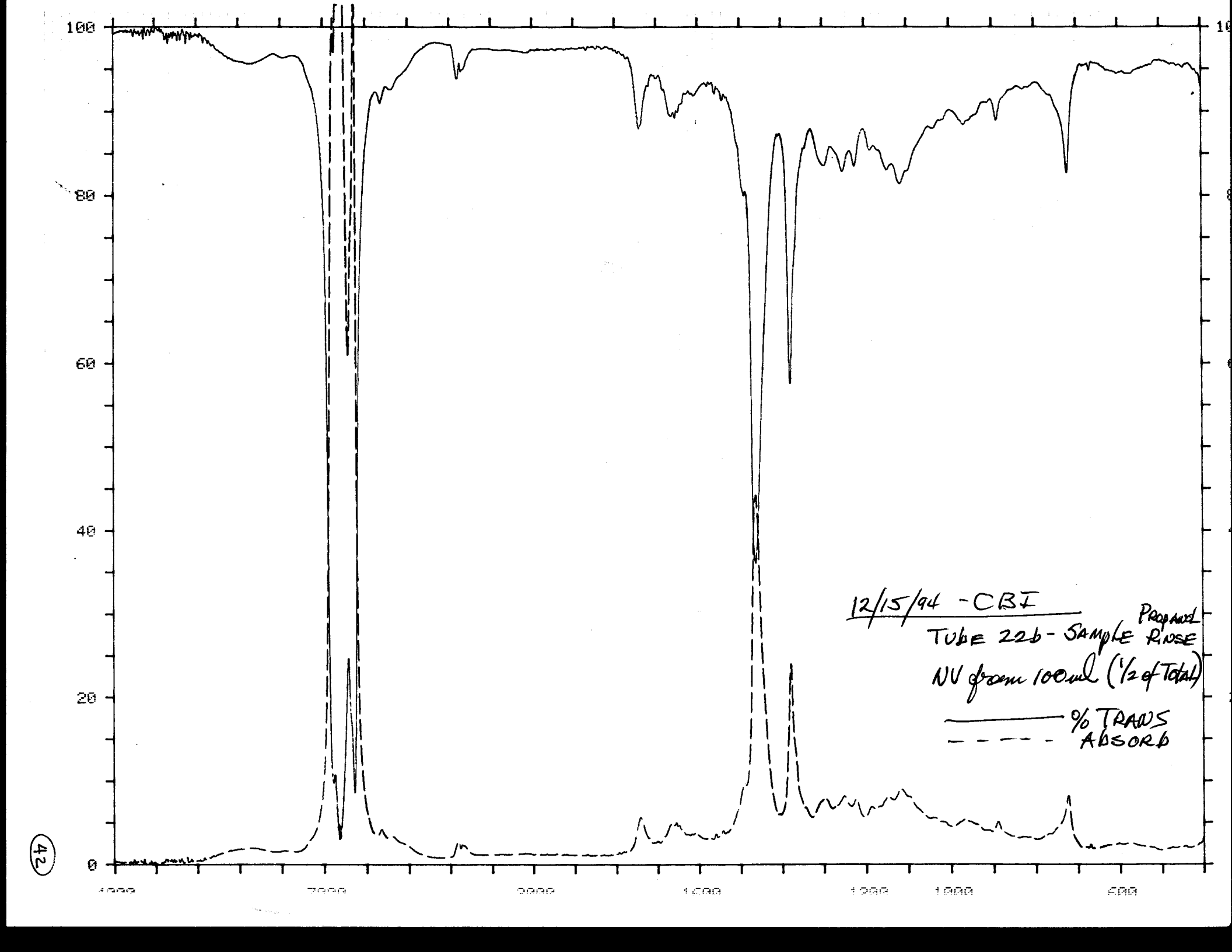
(23)

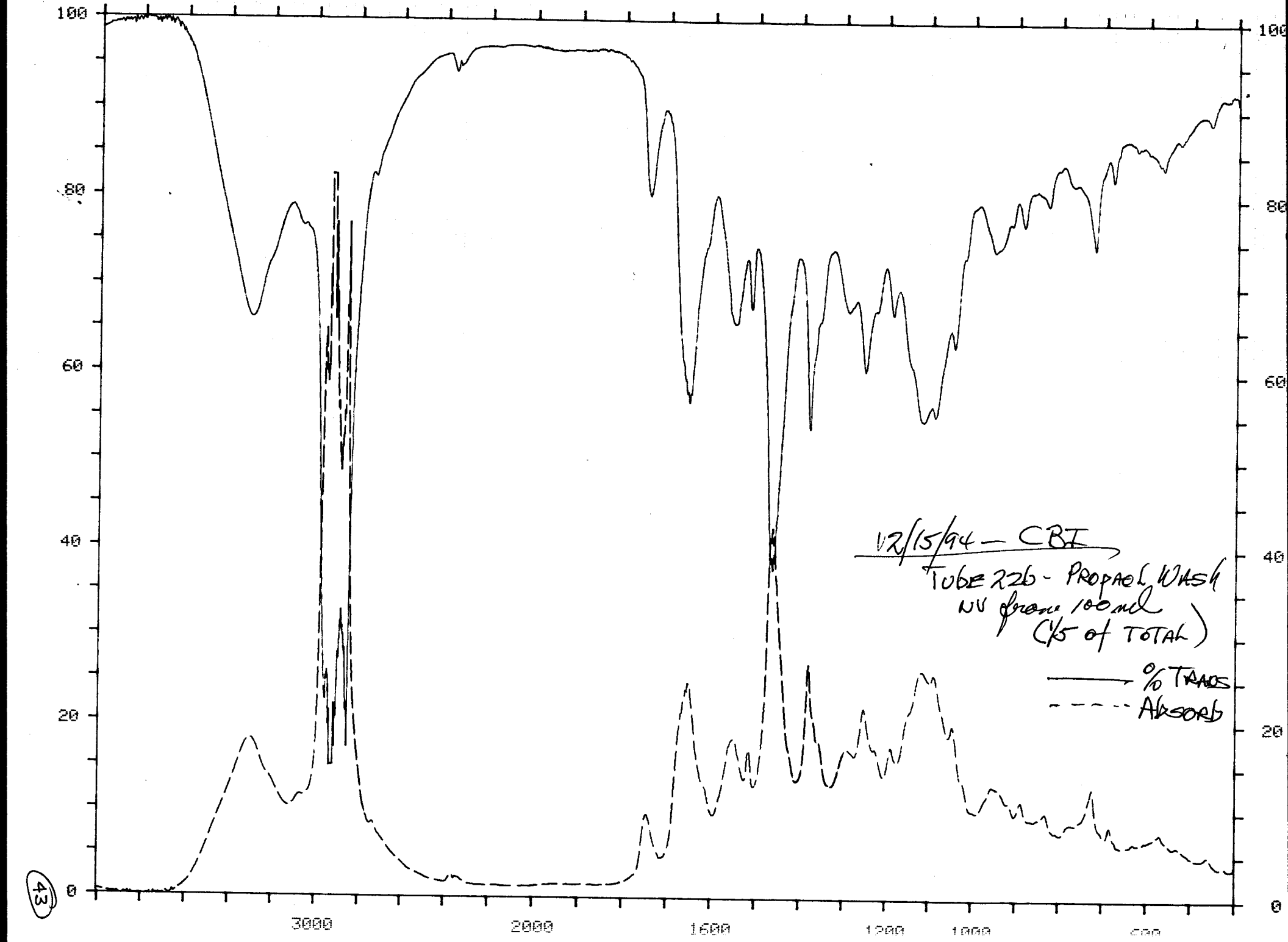

100
80
60
40
20
0
12/15/94 CBI
TUBE 22B - SAMPLE 2A
NV from 100 mL (½ total)
% TRANS
ABSORBANCE


100
80
60
40
20
0
4000
3000
2000
1600
1200
1000
600
12/15/94 - CRI
TUBE 22b - SAMPLE 3A
NV from 100ml (total sample)
% TRANS
ABSORB

(6)


100
80
60
40
20
0
12/15/94 CBI
TUBE 22b - SAMPLE 4A
NV from 100 mL (TOTAL SAMPLE)
% TRANS
ABSORB

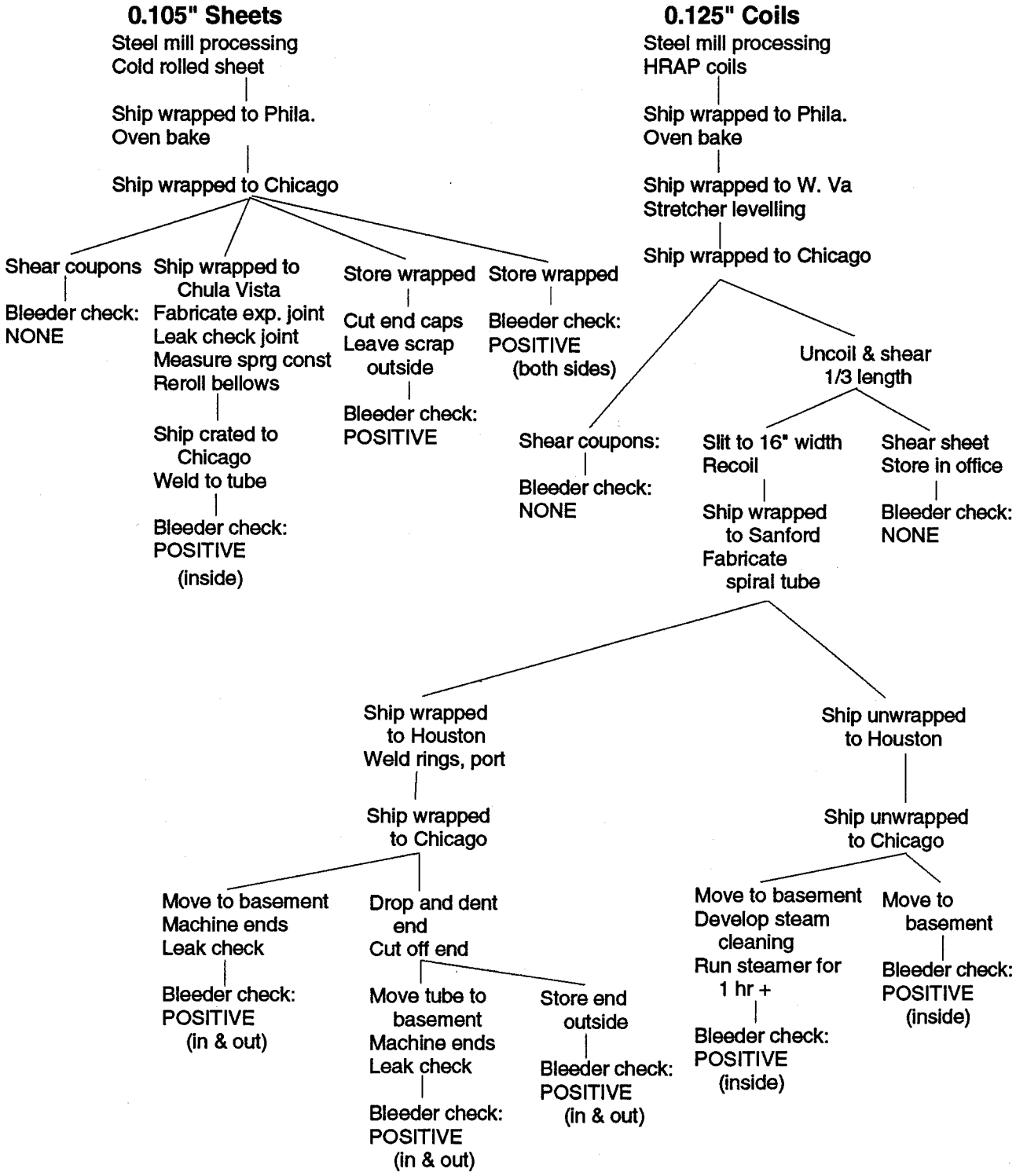

100
80
60
40
20
0
12/15/94 -CBI
PROPANOL
TUBE 22b - SAMPLE RINSE
NV from 100ml (1/2 of Total)
% TRANS
ABSORB


100
80
60
40
20
0
3000
2000
1600
1200
12/15/94 — CBT
TUBE 226 - PROPANOL WASH
UV from 100 mL
(1/5 of TOTAL)
% TRANS
ABSORB

14 REDACTED PAGES

10/21/94
L. Jones

BEAM TUBE SEQUENCE OF EVENTS, OCCURANCE OF BLEEDERS



FACSIMILE MESSAGE

CBI
1501 North Division Street
Plainfield, Illinois 60544-8929

Fax No. is: 815 439 6010
Verify No. is: 815 439 6000

November 4, 1994

To: Larry Jones
LIGO Project Caltech Pasadena, California

Fax No. (818)304-9834

From: M. L. Tellalian Phone (815)439-6517

Plainfield Engineering - PAE

RE: Vertical Cleaning Station Including Solvent Wash
LIGO Design & Qualification Test - Caltech Contract C146

Larry,

CBI has prepared a budget design and cost estimate for a vertical cleaning station which includes provisions for a solvent rinse. The main features of the facility are as follows:

- Four cleaning vertical cleaning stations for detergent spray, steam rinse, solvent rinse, and final inspection.
- Elevated clean room building for access to the tops of the vertical tube.
- Bottom receiving building at the bottom of the tubes.
- An open frame structure with mat foundation for support of the clean room.
- A moving floor structure or mats to enclose the bottom of the clean room around the tubes.
- Hoists and handling systems to raise the tube and move four tubes through the clean room to each station.
- Clean air supply system to provide clean air to the clean room and to force air down the vertical tubes as they are cleaned at each station.
- Systems to draw contaminated liquids and vapors from the bottom of the tube sections.
- Ground based steam detergent, steam rinse, and solvent wash systems including a distillation unit and vapor recovery unit to recycle the solvent and minimize the amount of vapors released.
- Systems for the cleaning and inspection stations to distribute solutions to the tube sections.

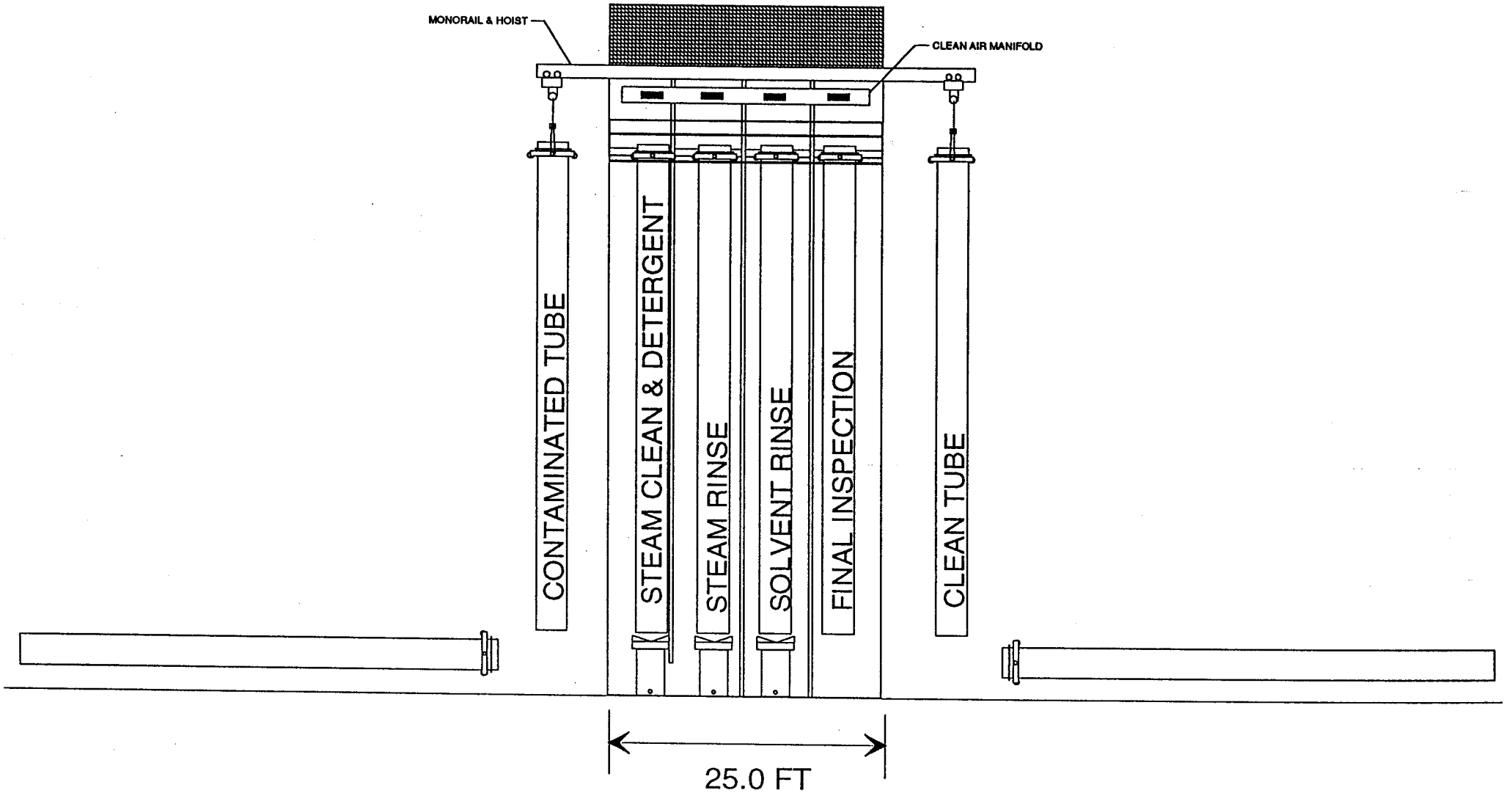
At the most, six tube sections can be suspended from the facility at any one time. The facility will always contain a total of four tube sections with one tube section at each station. CBI's estimated cost to furnish, install, and start up the cleaning facility is [redacted] with a variation of [redacted] The facility would be staffed by four or five workers which is two more than has previously been estimated for the cleaning station. This cleaning facility will not impact the construction schedule.

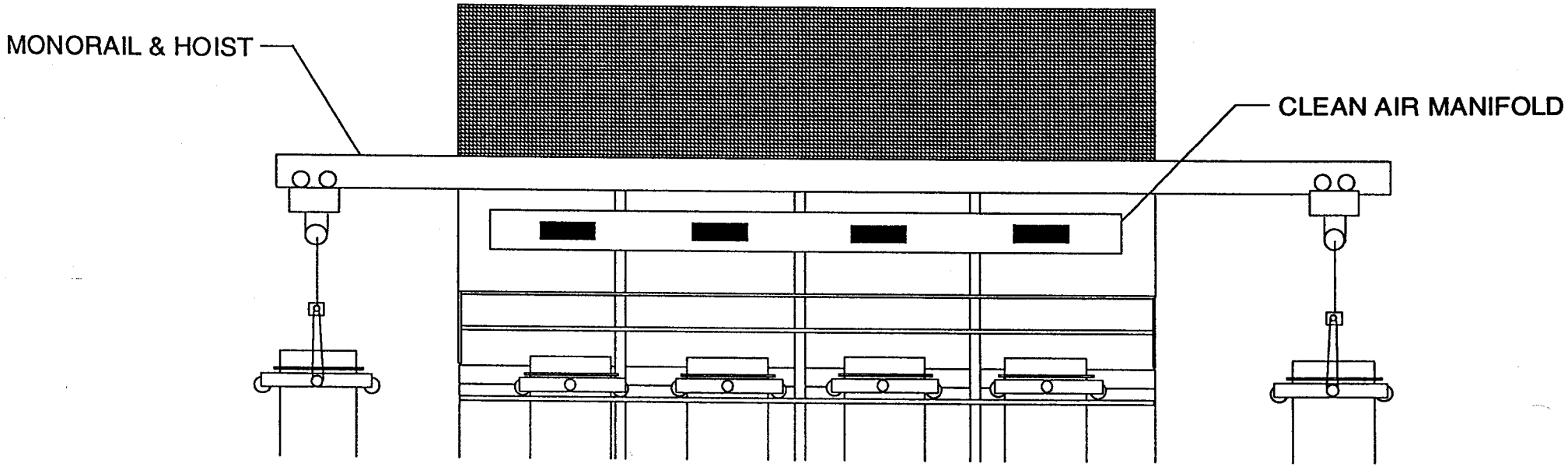
I hope this budget design and estimate meets with your needs. CBI will not refine the design or estimate unless requested to by Caltech. Give me a call if you have any questions.

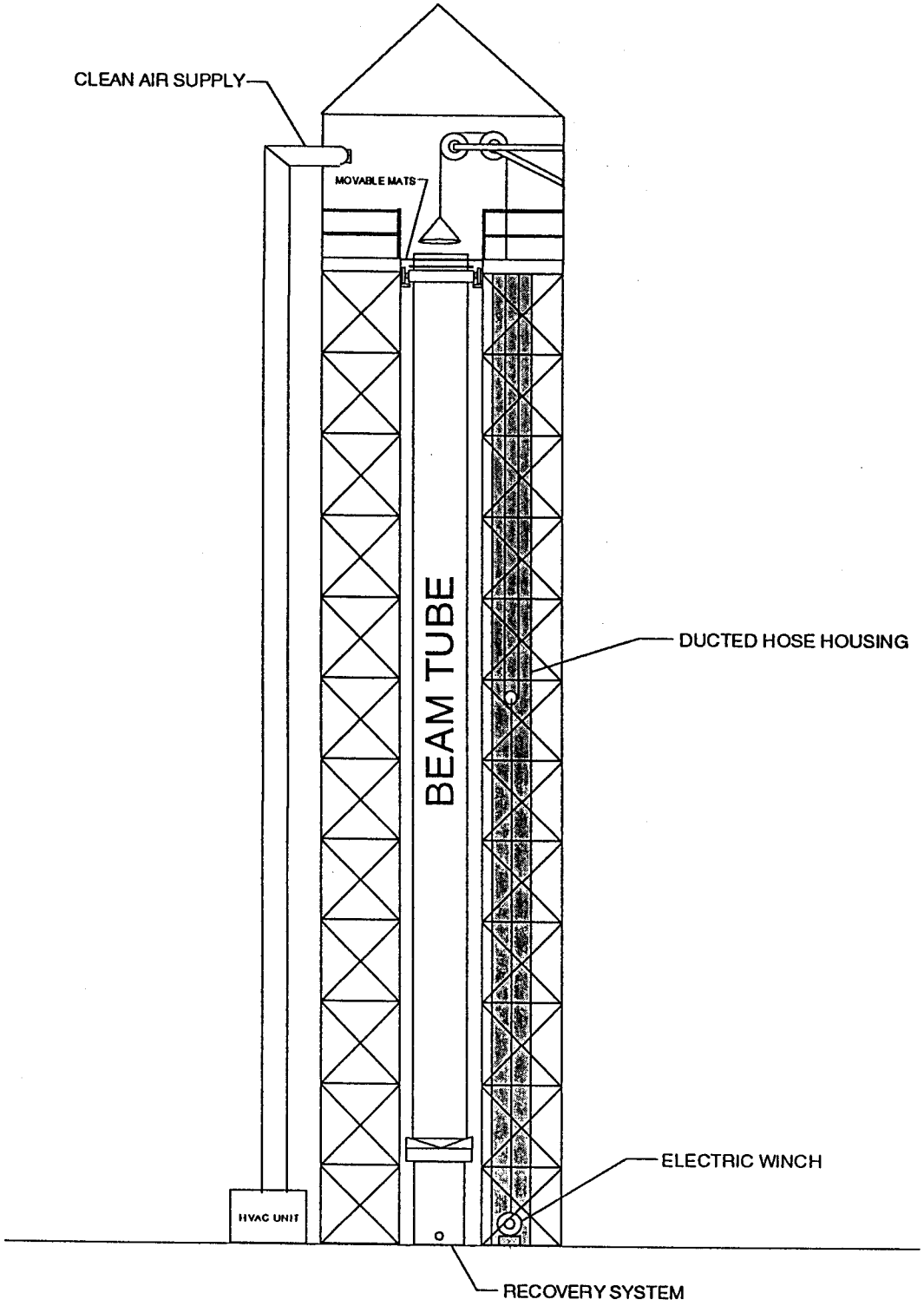
Regards,

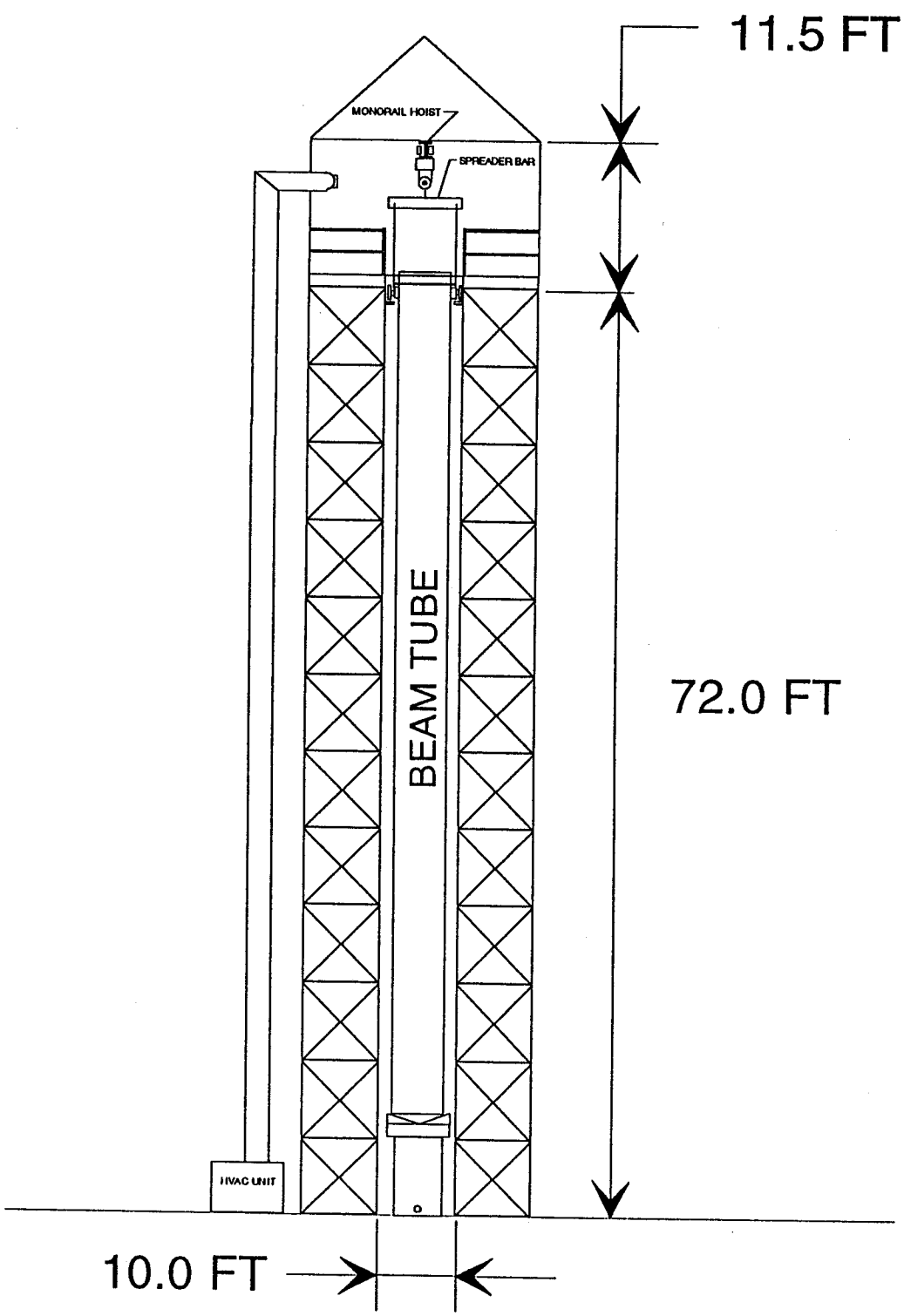
Marty

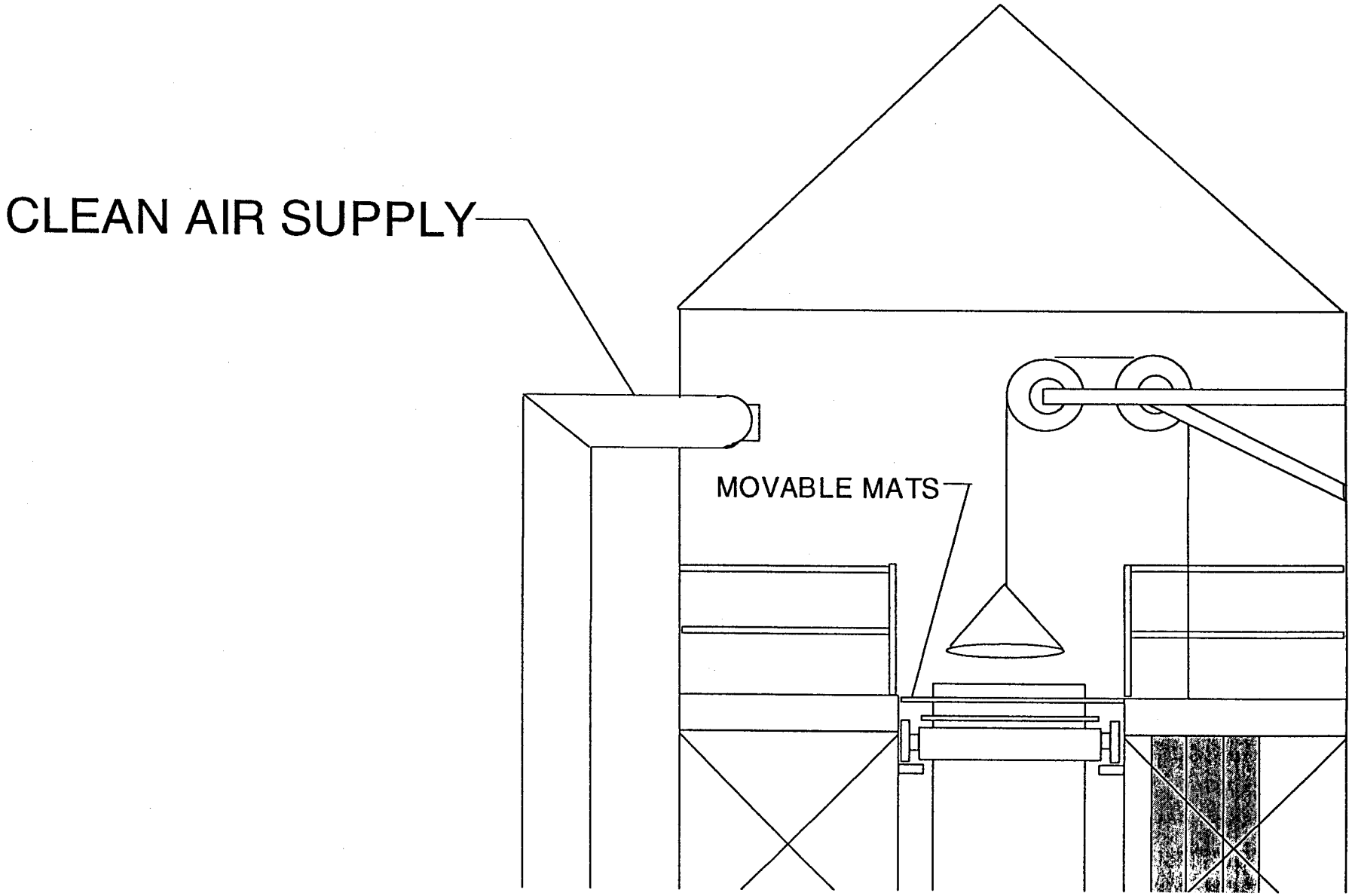
M. L. Tellalian - Plainfield Engineering

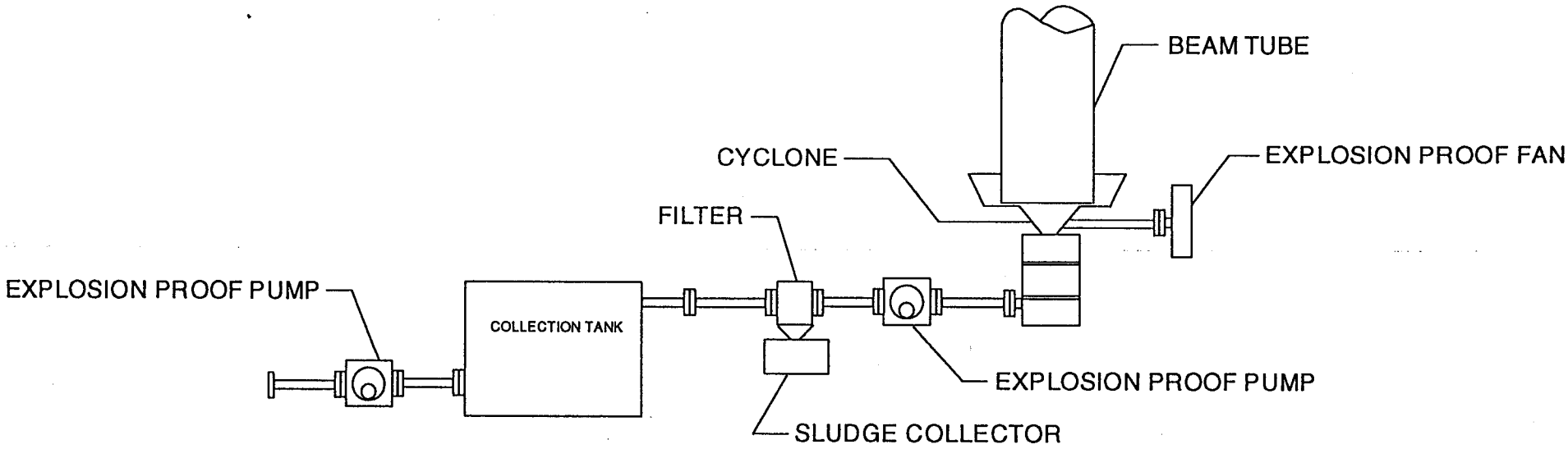

MONORAIL & HOIST
CLEAN AIR MANIFOLD
CONTAMINATED TUBE
STEAM CLEAN & DETERGENT
STEAM RINSE
SOLVENT RINSE
FINAL INSPECTION
CLEAN TUBE
25.0 FT

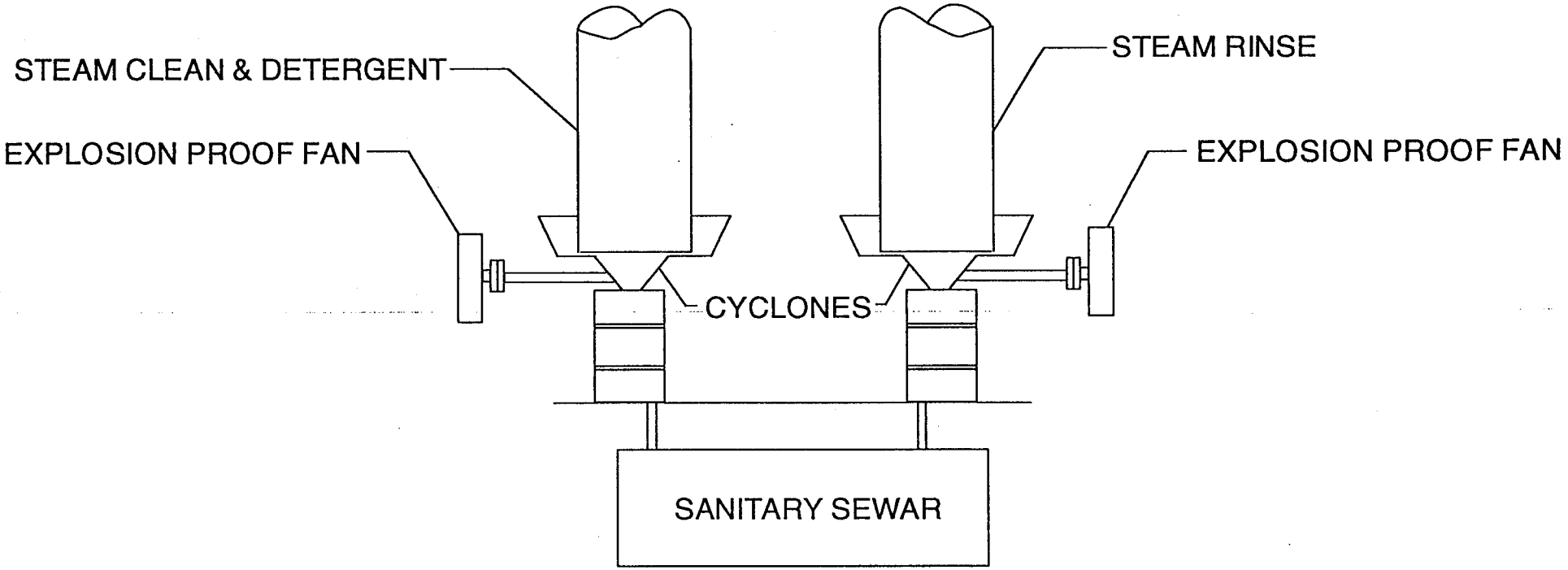

MONORAIL & HOIST
CLEAN AIR MANIFOLD


CLEAN AIR SUPPLY
MOVABLE MATS
BEAM TUBE
DUCTED HOSE HOUSING
ELECTRIC WINCH
HVAC UNIT
RECOVERY SYSTEM


11.5 FT
MONORAIL HOIST
SPREADER BAR
BEAM TUBE
72.0 FT
HVAC UNIT
10.0 FT


CLEAN AIR SUPPLY
MOVABLE MATS


BEAM TUBE
CYCLONE
EXPLOSION PROOF FAN
FILTER
EXPLOSION PROOF PUMP
COLLECTION TANK
EXPLOSION PROOF PUMP
SLUDGE COLLECTOR


STEAM CLEAN & DETERGENT
EXPLOSION PROOF FAN
STEAM RINSE
EXPLOSION PROOF FAN
CYCLONES
SANITARY SEWAR

FACSIMILE MESSAGE

CBI
1501 North Division Street
Plainfield, Illinois 60544-8929

Fax No. is: 815 439 6010
Verify No. is: 815 439 6000

November 23, 1994

To: Larry Jones
LIGO Project Caltech Pasadena, California

Fax No. (818)304-9834

From: M. L. Tellalian Phone (815)439-6517

Plainfield Engineering - PAE

RE: Horizontal Cleaning Station For the Mirachem Wash & Solvent Wash / Rinse
LIGO Design & Qualification Test - Caltech Contract C146

Larry,

CBI has prepared a budget design and estimate for three potential cleaning methods in the option. The cleaning facility presented at the FDR was a 50' X 87.5' insulated building which contained two cleaning stations. Ten tubes per week were cleaned in the horizontal position with a three man crew. Although additional equipment is required, the facility should be sufficient for the three options being considered. The three options and the budget prices are shown below:

1.) Mirachem wash and pressure water rinse prior to steam cleaning: [redacted]

- Cost of Mirachem including freight and disposal is $15 per gallon. This is based on returning used Mirachem to the manufacturer .
- Amount of Mirachem used is .2 gallons per foot or approximately 10,500 gallons.
- Cost of de-ionized water including disposal is $.25 per gallon. The amount of de-ionized water used for the pressure wash is 3 gallons per foot or approximately 156,000 gallons.
- The crew size has been increased by 1/2 man for the 80 week cleaning duration.

2.) Solvent wash and solvent rinse after steam cleaning: [redacted]

- The solvent is distilled on site and reused.
- Each use of solvent results in a 20% loss.
- The amount of solvent used for the wash and rinse is .2 gallons per foot.
- The total amount of solvent used is 21,000 gallons. The amount lost is 4,200.
- The cost of the solvent is $15 per gallon.
- The crew size has been increased by 1/2 man for the 80 week cleaning duration.

3.) Mirachem wash / water rinse prior to steam and solvent wash / rinse after steam: [redacted]

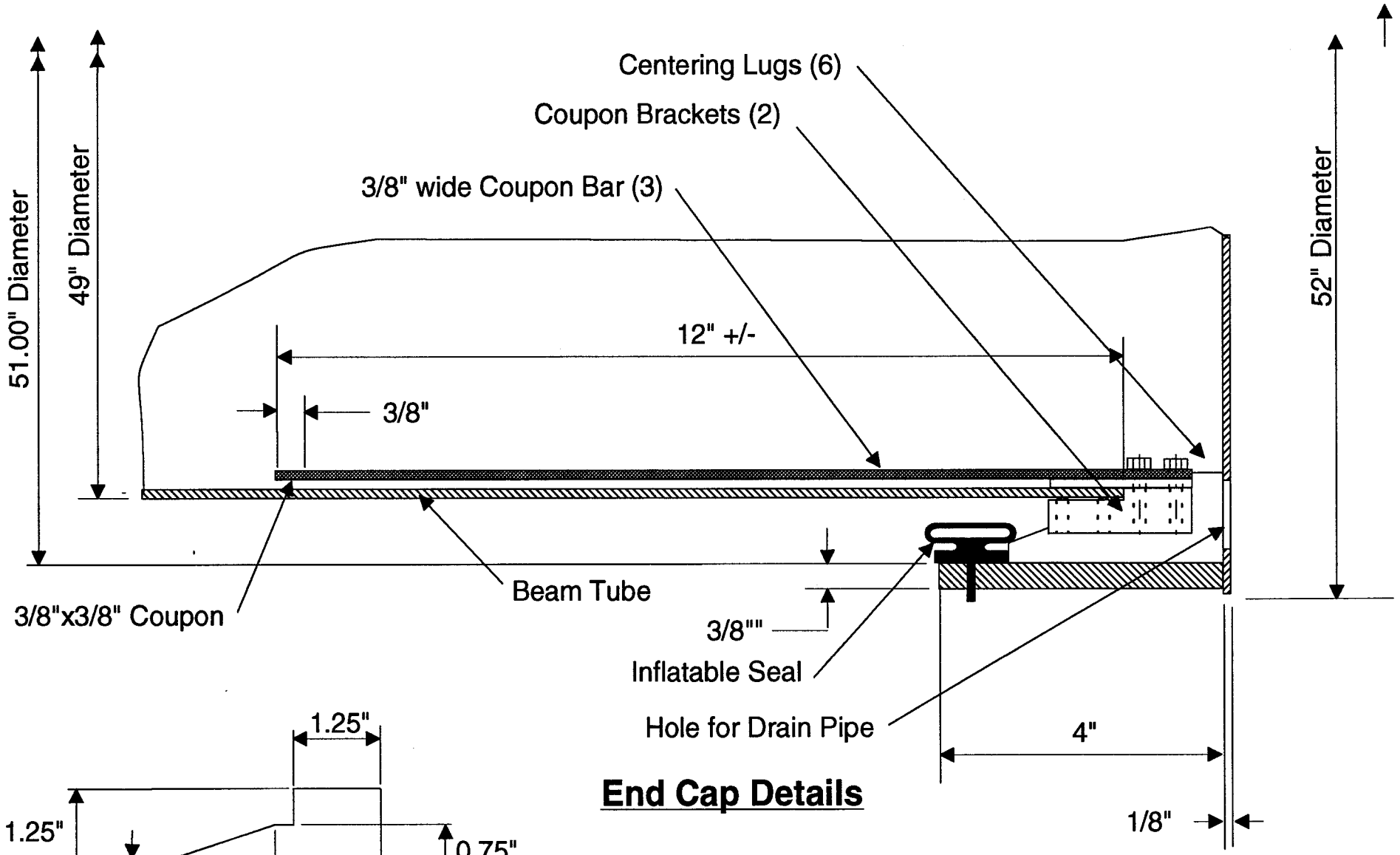
- The conditions show for the options above apply except for the man power requirements.
- The crew size has been increased by 1 man over the original three man crew for the 80 week cleaning duration.
- Some duplicate equipment in options 1 and 2 have been reduced resulting in a slight reduction.

As with the previous estimate, this estimate has a potential variation of [redacted]. The costs of performing these options in the QT are being developed and will be completed by our conference call today at 10:30 AM your time. Let me know if you need anything else prior to our conference call.

Regards,

M. L. Tellalian - Plainfield Engineering

cc: R. Weiss - FAX 617-253-7014

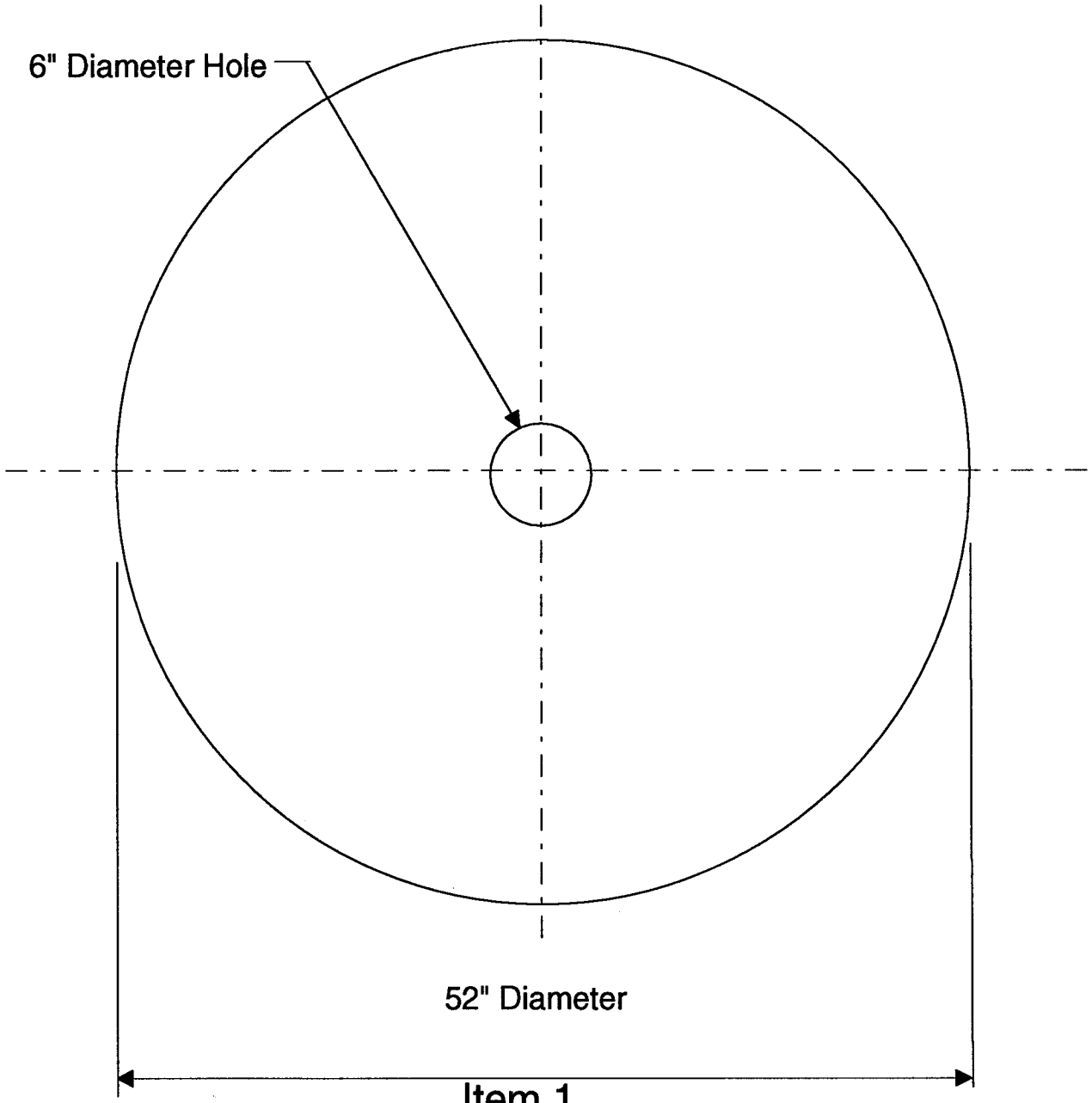


End Cap Details

Detail of Centering Lug

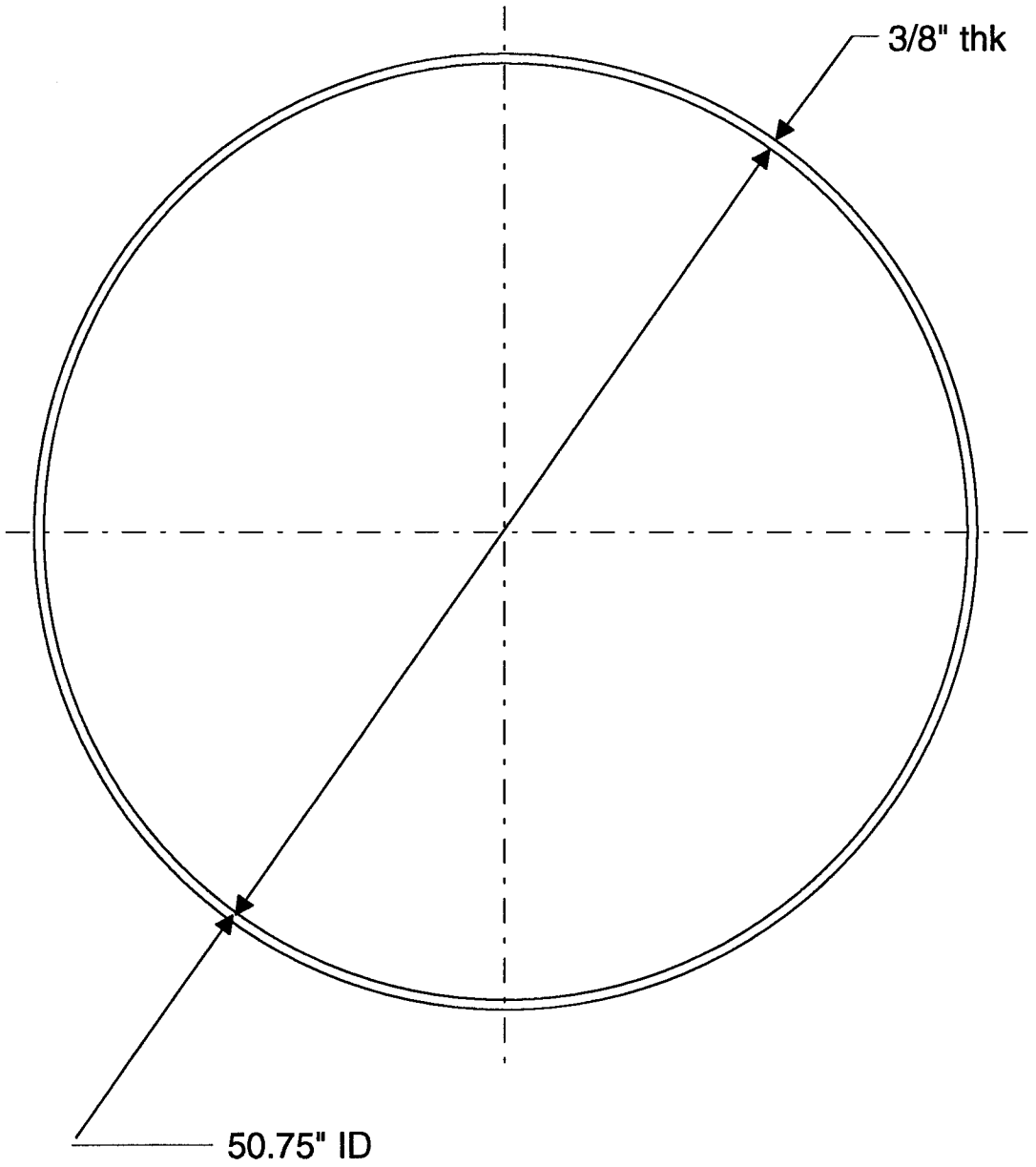
(6 Required)

Drawing: CLNCAP Rev. 1
By: SWP Date: 11/10/94



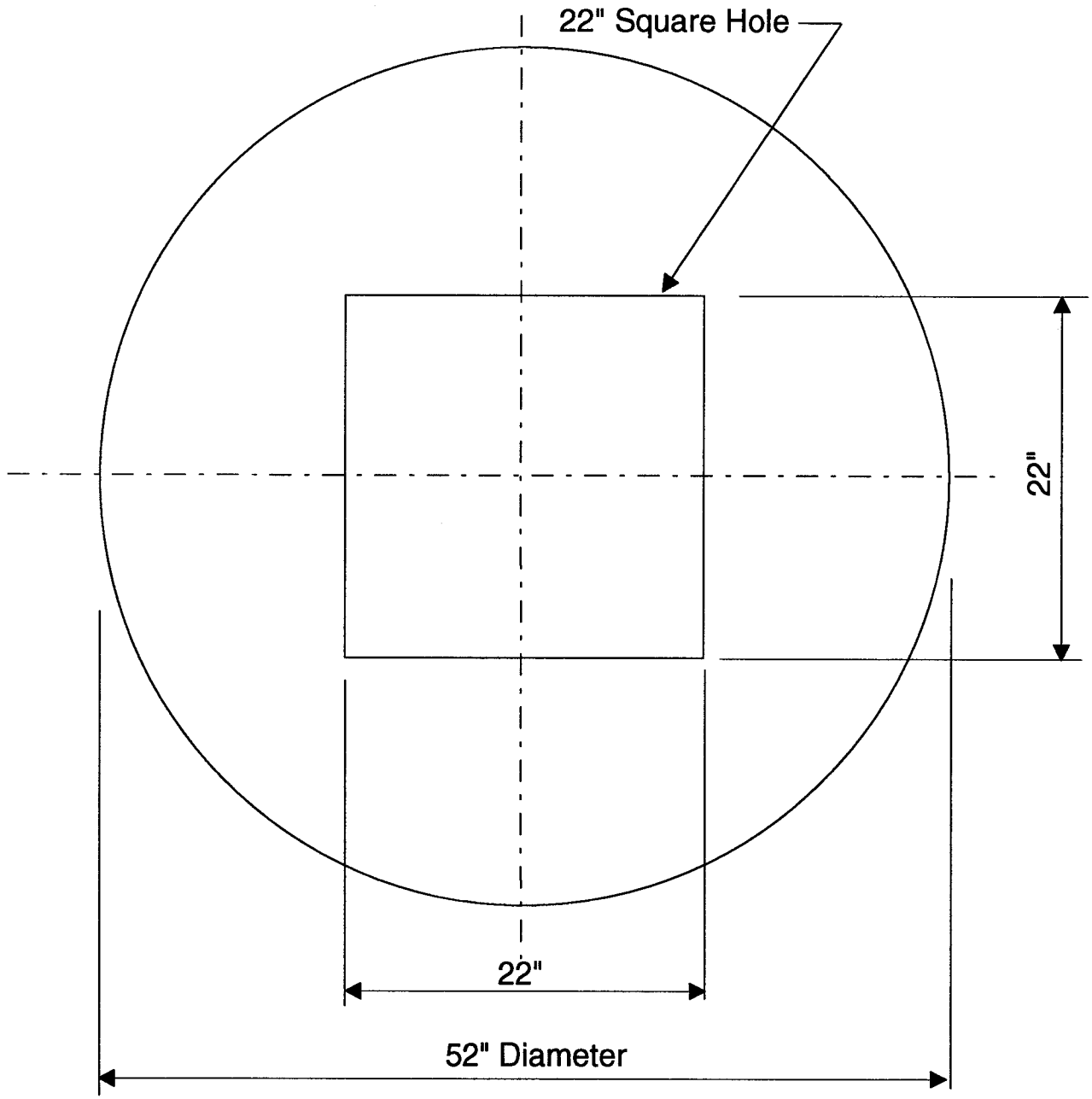
Item 1

(M/F 1/8" thk Aluminum Sheet - 1 Required)



Item 3

(M/F 4" Wide Aluminum Bar/Plate - 2 Required)



Item 2

(M/F 1/8" thk Aluminum Sheet - 1 Required)

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ATTN: SAFETY DIRECTOR
STEVE PETERS
CBI INDUSTRIES INC
CHICAGO BRIDGE & IRON
1501 N DIVISION ST
PLAINFIELD IL 60544-8984

DATE: 06/17/94
CUST#: 133884
PO#: 06-16-002

MATERIAL SAFETY DATA SHEET

SECTION 1. - - - - - - - - - - CHEMICAL IDENTIFICATION- - - - - - - - - -

PRODUCT #: 19076-4 NAME: 2-PROPANOL, 99.5+%, A.C.S. REAGENT

SECTION 2. - - - - - - COMPOSITION/INFORMATION ON INGREDIENTS - - - - - -

CAS #:67-63-0
MF: C3H8O

SYNONYMS
ALCOOL ISOPROPILICO (ITALIAN) * ALCOOL ISOPROPYLIQUE (FRENCH) * ALCOJEL * ALCOSOLVE * AVANTIN * AVANTINE * CHROMAR * COMBI-SCHUTZ * DIMETHYLCARBINOL * HARTOSOL * 2-HYDROXYPROPANE * IMSOL A * ISOHOL * ISOPROPANOL * ISOPROPANOL (DOT) * ISOPROPYL ALCOHOL (ACGIH,DOT,OSHA) * ISO-PROPYLALKOHOL (GERMAN) * LUTOSOL * PETROHOL * PRO * PROPAN-2-OL * 2-PROPANOL * I-PROPANOL (GERMAN) * N-PROPAN-2-OL * PROPOL * SEC-PROPYL ALCOHOL * 2-PROPYL ALCOHOL * I-PROPYLALKOHOL (GERMAN) * SPECTRAR * STERISOL HAND DISINFECTANT * TAKINEOCOL * UN1219 (DOT) *

SECTION 3. - - - - - - - - - - HAZARDS IDENTIFICATION - - - - - - - - -

LABEL PRECAUTIONARY STATEMENTS
FLAMMABLE (USA DEFINITION)
HIGHLY FLAMMABLE (EUROPEAN DEFINITION)
IRRITANT
IRRITATING TO EYES, RESPIRATORY SYSTEM AND SKIN.
RISK OF SERIOUS DAMAGE TO EYES.
TARGET ORGAN(S):
NERVES
KIDNEYS
KEEP AWAY FROM SOURCES OF IGNITION. NO SMOKING.
IN CASE OF CONTACT WITH EYES, RINSE IMMEDIATELY WITH PLENTY OF WATER AND SEEK MEDICAL ADVICE.
WEAR SUITABLE PROTECTIVE CLOTHING.
HYGROSCOPIC
KEEP TIGHTLY CLOSED.

SECTION 4. - - - - - - - - - - FIRST-AID MEASURES- - - - - - - - - -

IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES WITH COPIOUS AMOUNTS OF WATER FOR AT LEAST 15 MINUTES.
ASSURE ADEQUATE FLUSHING OF THE EYES BY SEPARATING THE EYELIDS

CONTINUED ON NEXT PAGE

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CUST#: 133884
PO#: 06-16-002

PRODUCT #: 190764 NAME: 2-PROPANOL, 99.5+%, A.C.S. REAGENT
MF: C3H8O

WITH FINGERS.
IN CASE OF CONTACT, IMMEDIATELY WASH SKIN WITH SOAP AND COPIOUS AMOUNTS OF WATER.
IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN.
IF SWALLOWED, WASH OUT MOUTH WITH WATER PROVIDED PERSON IS CONSCIOUS.
CALL A PHYSICIAN.
REMOVE AND WASH CONTAMINATED CLOTHING PROMPTLY.

SECTION 5. - - - - - - - - - - FIRE FIGHTING MEASURES - - - - - - - - - -

EXTINGUISHING MEDIA
CARBON DIOXIDE, DRY CHEMICAL POWDER OR APPROPRIATE FOAM.
SPECIAL FIREFIGHTING PROCEDURES
WEAR SELF-CONTAINED BREATHING APPARATUS AND PROTECTIVE CLOTHING TO PREVENT CONTACT WITH SKIN AND EYES.
USE WATER SPRAY TO COOL FIRE-EXPOSED CONTAINERS.
FLAMMABLE LIQUID.
UNUSUAL FIRE AND EXPLOSIONS HAZARDS
VAPOR MAY TRAVEL CONSIDERABLE DISTANCE TO SOURCE OF IGNITION AND FLASH BACK.
CONTAINER EXPLOSION MAY OCCUR UNDER FIRE CONDITIONS.

SECTION 6. - - - - - - - - - ACCIDENTAL RELEASE MEASURES- - - - - - - - -

SHUT OFF ALL SOURCES OF IGNITION.
EVACUATE AREA.
WEAR SELF-CONTAINED BREATHING APPARATUS, RUBBER BOOTS AND HEAVY RUBBER GLOVES.
ABSORB ON SAND OR VERMICULITE AND PLACE IN CLOSED CONTAINERS FOR DISPOSAL.
USE NONSPARKING TOOLS.
VENTILATE AREA AND WASH SPILL SITE AFTER MATERIAL PICKUP IS COMPLETE.

SECTION 7. - - - - - - - - - - HANDLING AND STORAGE- - - - - - - - - -

REFER TO SECTION 8.

CONTINUED ON NEXT PAGE

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CUST#: 133884
PO#: 06-16-002

PRODUCT #: 190764 NAME: 2-PROPANOL, 99.5+%, A.C.S. REAGENT
MF: C3H8O

SECTION 8. - - - - - - EXPOSURE CONTROLS/PERSONAL PROTECTION- - - - - -

CHEMICAL SAFETY GOGGLES.
SAFETY SHOWER AND EYE BATH.
RUBBER GLOVES.
MECHANICAL EXHAUST REQUIRED.
NIOSH/MSHA-APPROVED RESPIRATOR.
DO NOT GET IN EYES, ON SKIN, ON CLOTHING.
DO NOT BREATHE VAPOR.
WASH THOROUGHLY AFTER HANDLING.
SEVERE EYE IRRITANT.
KEEP TIGHTLY CLOSED.
KEEP AWAY FROM HEAT, SPARKS, AND OPEN FLAME.
HYGROSCOPIC
STORE IN A COOL DRY PLACE.

SECTION 9. - - - - - - - PHYSICAL AND CHEMICAL PROPERTIES - - - - - - -

APPEARANCE AND ODOR
COLORLESS LIQUID
BOILING POINT: 82.4 C
MELTING POINT: -89.5 C
FLASHPOINT 53 F
11C
AUTOIGNITION TEMPERATURE: 750 F 398C
UPPER EXPLOSION LEVEL: 12%
LOWER EXPLOSION LEVEL: 2.5%
VAPOR PRESSURE: 33MM 20 C
VAPOR DENSITY: 2
SPECIFIC GRAVITY: 0.785

33 mm / 760 mm/ATM = 14.7 PSIA / ATM = .638 PSIA

14.7 (.025) = .368 PSIA

SECTION 10. - - - - - - - - -STABILITY AND REACTIVITY - - - - - - - - -

INCOMPATIBILITIES
OXIDIZING AGENTS
ACIDS
ACID ANHYDRIDES
HALOGENS
ALUMINUM

CONTINUED ON NEXT PAGE

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MATERIAL SAFETY DATA SHEET

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PRODUCT #: 190764 NAME: 2-PROPANOL, 99.5+%, A.C.S. REAGENT
MF: C3H8O

HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS
TOXIC FUMES OF:
CARBON MONOXIDE, CARBON DIOXIDE

SECTION 11. - - - - - - - - - - TOXICOLOGICAL INFORMATION - - - - - - - - -

ACUTE EFFECTS
MAY BE HARMFUL BY INHALATION, INGESTION, OR SKIN ABSORPTION.
CAUSES SEVERE EYE IRRITATION.
CAUSES SKIN IRRITATION.
MATERIAL IS IRRITATING TO MUCOUS MEMBRANES AND UPPER RESPIRATORY TRACT.
CAN CAUSE CNS DEPRESSION.
PROLONGED EXPOSURE CAN CAUSE:
NAUSEA, HEADACHE AND VOMITING
NARCOTIC EFFECT
PROLONGED OR REPEATED EXPOSURE TO SKIN CAUSES DEFATTING AND DERMATITIS.
CHRONIC EFFECTS
TARGET ORGAN(S):
NERVES
KIDNEYS
RTECS NO: NT8050000
ISOPROPYL ALCOHOL
IRRITATION DATA

SKN-RBT 500 MG MLD	NTIS** AD-A106-944
EYE-RBT 100 MG SEV	AJOPAA 29,1363,46
EYE-RBT 10 MG MOD	TXAPA9 55,501,80
EYE-RBT 100 MG/24H MOD	85JCAE -,191,86

TOXICITY DATA

ORL-MAN LDLO:5272 MG/KG	AJCPAI 38,144,62
ORL-HMN LDLO:3570 MG/KG	34ZIAG -,339,69
UNR-MAN LDLO:2770 MG/KG	85DCAI 2,73,70
ORL-RAT LD50:5045 MG/KG	GISAAA 43(1),8,78
IPR-RAT LD50:2735 MG/KG	EVHPAZ 61,321,85
IVN-RAT LD50:1088 MG/KG	EVHPAZ 61,321,85
ORL-MUS LD50:3600 MG/KG	GISAAA 43(1),8,78
IPR-MUS LD50:4477 MG/KG	EVHPAZ 61,321,85
IVN-MUS LD50:1509 MG/KG	EVHPAZ 61,321,85
ORL-RBT LD50:6410 MG/KG	FAONAU 48A,114,70

CONTINUED ON NEXT PAGE

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CUST#: 133884
PO#: 06-16-002

PRODUCT #: 190764 NAME: 2-PROPANOL, 99.5+%, A.C.S. REAGENT
MF: C3H8O

SKN-RBT LD50:12800 MG/KG NPIRI* 1,100,74
IPR-RBT LD50:667 MG/KG EVHPAZ 61,321,85
IVN-RBT LD50:1184 MG/KG EVHPAZ 61,321,85
IPR-GPG LD50:2560 MG/KG EVHPAZ 61,321,85
IPR-HAM LD50:3444 MG/KG EVHPAZ 61,321,85

TARGET ORGAN DATA
BEHAVIORAL (HALLUCINATIONS, DISTORTED PERCEPTIONS)
CARDIAC (PULSE RATE DECREASED WITH FALL IN BP)
VASCULAR (BP LOWERING NOT CHARACTERIZED IN AUTONOMIC SECTION)
GASTROINTESTINAL (NAUSEA OR VOMITING)
EFFECTS ON EMBRYO OR FETUS (FETAL DEATH)
ONLY SELECTED REGISTRY OF TOXIC EFFECTS OF CHEMICAL SUBSTANCES (RTECS) DATA IS PRESENTED HERE. SEE ACTUAL ENTRY IN RTECS FOR COMPLETE INFORMATION.

SECTION 12. - - - - - - - - - - ECOLOGICAL INFORMATION - - - - - - - - - -

DATA NOT YET AVAILABLE.

SECTION 13. - - - - - - - - - - DISPOSAL CONSIDERATIONS - - - - - - - - - -

BURN IN A CHEMICAL INCINERATOR EQUIPPED WITH AN AFTERBURNER AND SCRUBBER BUT EXERT EXTRA CARE IN IGNITING AS THIS MATERIAL IS HIGHLY FLAMMABLE.
OBSERVE ALL FEDERAL, STATE AND LOCAL ENVIRONMENTAL REGULATIONS.

SECTION 14. - - - - - - - - - - TRANSPORT INFORMATION - - - - - - - - - -

CONTACT ALDRICH CHEMICAL COMPANY FOR TRANSPORTATION INFORMATION.

SECTION 15. - - - - - - - - - - REGULATORY INFORMATION - - - - - - - - - -

REVIEWS, STANDARDS, AND REGULATIONS
ACGIH TLV-TWA 400 PPM; STEL 500 PPM 85INA8 6,828,91
IARC CANCER REVIEW:ANIMAL INADEQUATE EVIDENCE IMEMDT 15,223,77
IARC CANCER REVIEW:HUMAN INADEQUATE EVIDENCE IMSUDL 7,229,87
IARC CANCER REVIEW:GROUP 3 IMSUDL 7,229,87
EPA FIFRA 1988 PESTICIDE SUBJECT TO REGISTRATION OR RE-REGISTRATION
FEREAC 54,7740,89

CONTINUED ON NEXT PAGE

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Switzerland Aldrich Chemie Industriestrasse 25 CH-9470 Buchs Telephone: 41817552723 Fax: 41817567420
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CUST#: 133884
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PRODUCT #: 190764 NAME: 2-PROPANOL, 99.5+%, A.C.S. REAGENT
MF: C3H8O

MSHA STANDARD-AIR:TWA 400 PPM (980 MG/M3)
DTLVS* 3,141,71
OSHA PEL:8H TWA 400 PPM (980 MG/M3)
FEREAC 54,2923,89
OSHA PEL FINAL:8H TWA 400 PPM (980 MG/M3);STEL 500 PPM (1225 MG/M3)
FEREAC 54,2923,89
OEL-AUSTRALIA:TWA 400 PPM (980 MG/M3);STEL 500 PPM (1225 MG/M3) JAN93
OEL-BELGIUM:TWA 400 PPM (985 MG/M3);STEL 500 PPM (1230 MG/M3) JAN93
OEL-DENMARK:TWA 200 PPM (490 MG/M3);SKIN JAN93
OEL-FRANCE:STEL 400 PPM (980 MG/M3) JAN93
OEL-GERMANY:TWA 400 PPM (980 MG/M3) JAN93
OEL-JAPAN:STEL 400 PPM (980 MG/M3) JAN93
OEL-THE NETHERLANDS:TWA 400 PPM (980 MG/M3);SKIN JAN93
OEL-THE PHILIPPINES:TWA 400 PPM (980 MG/M3) JAN93
OEL-RUSSIA:STEL 400 PPM (10 MG/M3) JAN93
OEL-SWEDEN:TWA 150 PPM (350 MG/M3);STEL 250 PPM (600 MG/M3) JAN93
OEL-SWITZERLAND:TWA 400 PPM (980 MG/M3);STEL 800 PPM JAN93
OEL-TURKEY:TWA 200 PPM (500 MG/M3) JAN93
OEL-UNITED KINGDOM:TWA 400 PPM (980 MG/M3);STEL 500 PPM;SKIN JAN93
OEL IN BULGARIA, COLOMBIA, JORDAN, KOREA CHECK ACGIH TLV
OEL IN NEW ZEALAND, SINGAPORE, VIETNAM CHECK ACGIH TLV
NIOSH REL TO ISOPROPYL ALCOHOL-AIR:10H TWA 400 PPM;STEL 500 PPM
NIOSH* DHHS #92-100,92
NOHS 1974: HZD 40987; NIS 465; TNF 213605; NOS 252; TNE 3183554
NOES 1983: HZD 40987; NIS 442; TNF 166327; NOS 270; TNE 4290990; TFE 1954610
EPA GENETOX PROGRAM 1988, NEGATIVE: CELL TRANSFORM.-SA7/SHE; N CRASSA-ANEUPLOIDY
EPA TSCA CHEMICAL INVENTORY, JUNE 1993
EPA TSCA SECTION 8(E) STATUS REPORT 8EHQ-1180-0371
EPA TSCA SECTION 8(E) STATUS REPORT 8EHQ-0985-0566
EPA TSCA TEST SUBMISSION (TSCATS) DATA BASE, JANUARY 1994
NIOSH ANALYTICAL METHODS: SEE ALCOHOLS I, 1400

SECTION 16. - - - - - - - - - - OTHER INFORMATION- - - - - - - - - - -

THE ABOVE INFORMATION IS BELIEVED TO BE CORRECT BUT DOES NOT PURPORT TO BE ALL INCLUSIVE AND SHALL BE USED ONLY AS A GUIDE. ALDRICH SHALL NOT BE

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MF: C3H8O

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