THE STATE of ALASKA
GOVERNOR BILL WALKER

Department of Commerce, Community, and Economic Development

ALCOHOL & MARIJUANA CONTROL OFFICE
550 West 7th Avenue, Suite 1600
Anchorage, AK 99501
Main: 907.269.0350

MEMORANDUM

TO: Chair and Members of the Board
DATE: June 30, 2016

FROM: Cynthia Franklin
Director, Marijuana Control Board
RE: Applications That Have Changes to Operating Plans

At its June 9-10 meeting, the Marijuana Control Board delegated the following applications. After the meeting, each applicant attempted to submit significant changes to their premises diagrams, operating plans, or both.

1. License #10022 Sunrise Gardens- Tab 25
    a. Changing indoor cultivation to use first floor only
2. License #10043 Alaskan Greenery- Tab 26
    a. Change to security system provider only
3. License #10186 AK Green Labs, LLC- Tab 27 (DISCUSS OF OWNERSHIP CHANGES)- Tab 27
    a. Amended some parts of form MJ-06
    b. Media article published reporting that ownership of license changed
4. License #10207 Tanana Herb Company, LLC- Tab 28
    a. Changed location of bathroom per FNSB direction
    b. Applicant was aware when she appeared before MCB June 9 that change would be required but she did not inform the board of need to change before they voted

Because the board delegated authority to issue licenses based the diagrams and operating plans submitted to the board in June, these changes necessitate the board removing the delegation to review the changed operating plans. The Program Coordinator created Forms MJ-14 and MJ-15. The following list indicates which pages of the operating plan are altered by MJ-15. The indicated tabs contain the following documents:

1. MJ-15 for each license
2. Pages of operating plan changed as required by MJ-15
3. Original Operating Plan viewed by MCB at June meeting
4. MJ-14 if applicable
5. For License #10186, copy of media article outlining new ownership of license

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Alaska Marijuana Control Board

Form MJ-15: Operating Plan Change

What is this form?

This operating plan change form is required for all marijuana establishment licensees seeking to change a licensed marijuana establishment's existing operating plan, under 3 AAC 306.100. With this form, a licensee may request changes to as much or as little as desired of Form MJ-01 and/or the corresponding operating plan supplemental for the establishment's license type.
The required $250 change fee may be made by credit card online (VISA, MasterCard, or Discover), or by check or money order.

Please download, complete, and submit with this form **only the pages** of Form MJ-01 and/or the corresponding operating plan supplemental that contain sections that you are requesting to change. All fields that are left blank will be considered unchanged from the existing operating plan. All fields that are completed and submitted with this form will be considered as changes to the existing operating plan and are subject to board approval. **Please do not submit any wholly unchanged pages of an operating plan.**

The form(s) that I am requesting board approval to change is:

RECEIVED
JUN 23 2016
BY: AMCO

- ☐ **Form MJ-01:** Marijuana Establishment Operating Plan
- ☐ **Form MJ-03:** Retail Marijuana Store Operating Plan Supplemental
- ☐ **Form MJ-04:** Marijuana Cultivation Facility Operating Plan Supplemental
- ☐ **Form MJ-05:** Marijuana Product Manufacturing Facility Operating Plan Supplemental
- ☑ **Form MJ-06:** Marijuana Testing Facility Operating Plan Supplemental

This form must be completed and submitted to AMCO's main office prior to changing existing operations. The licensed establishment's operations may not be altered unless and until the Marijuana Control Board has approved of the changes. Please note that licensees seeking to change operating plans for multiple licenses must submit a separate completed copy of this form for each license.

Section 1 – Establishment Information

Enter information for the licensed establishment.

Licensee:	AK Green Labs LLC	**License Number:**	10186		
License Type:	Marijuana Testing Facility				
Doing Business As:	AK Green Labs LLC				
Premises Address:	2509 Fairbanks Street, Suite A				
City:	Anchorage	**State:**	AK	**ZIP:**	99503

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Alaska Marijuana Control Board

Form MJ-15: Operating Plan Change

As a marijuana establishment licensee, I declare under penalty of unsworn falsification that I have examined this form, including all accompanying documents, schedules, and statements, and to the best of my knowledge and belief find them to be true, correct, and complete.

Signature of licensee

Brian Coyle

Printed name

Subscribed and sworn to before me this 23 day of June, 2016.

Notary Public
SHARON R. LEIPPI
State of Alaska
My Commission Expires Jun 8, 2018

Sharon R. Leippi
Notary Public in and for the State of Alaska.

My commission expires: June 8, 2018

RECEIVED
JUN 23 2016
BY: Anna

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Alaska Marijuana Control Board

Operating Plan Supplemental
Form MJ-06: Marijuana Testing Facility

Section 2 – Prohibitions

Applicants should review 3 AAC 306.610 and be able to answer "Agree" to all items below.

The marijuana testing facility will not:	Agree	Disagree
Sell, deliver, distribute or transfer any marijuana or marijuana product to a consumer, with or without compensation	☐	☐
Allow any person to consume marijuana or marijuana product on its licenses premises	☐	☐

Section 3 – Testing Practices and Procedures

Review the requirements under 3 AAC 306.615, 3 AAC 306.635 – 3AAC 306.645, and 3 AAC 306.660, and identify how the proposed establishment will meet the listed requirements.

Describe each test the marijuana testing facility will offer:

Potency analysis of cannabis flower and trim, using near-infrared spectroscopy, to determine concentrations of THC, THCA, CBD and CBDA.

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Operating Plan Supplemental
Form MJ-06: Marijuana Testing Facility

Standard Operating Procedure Manual (3 AAC 306.640):

Applicants for marijuana testing facilities must have a written procedures manual with detailed instructions explaining how to perform each testing method the applicant or marijuana testing facility uses, and minimum standards for each test. Applicants should be able to answer "Agree" to all items below.

The marijuana testing facility will ensure that the standard operating procedure manual:	Agree	Disagree
Is available to each employee at all times	☐	☐
Will cover at least the required procedures listed under 3 AAC 306.640	☐	☐

Describe the marijuana testing facility's standard operating procedure for each test the facility will offer:

OBJ OBJ OBJ OBJ OBJ

Procedure for Potency Analysis Using the QuantaCann2, Near-Infrared Spectroscopy

1. Grind raw plant material (dried flower) to the required size (1-2mm).
2. Fill the Sample Cup with fresh-ground flower. Compress it closed with the quartz window facing down and twist to lock the sample cover.
3. Click on the link labeled SCAN to go to the Scan Page.
4. Fill in the form to describe the sample. Note: Only "Sample Name" is required; the remaining fields are optional.
5. Click NEXT to go to the Calibration page.
6. Place the White Reference (provided with your system) on the optical scanning area with the white side facing down and click the NEXT button to start the calibration scan. The calibration scan will continue for roughly 30 seconds.
7. After the calibration scan has completed, remove the White Reference, being certain to place it neatly into the protective cover.
8. Place the Sample Cup with test sample, quartz side facing down, into the optical scanning area and click the NEXT button to start the sample scan. The scan swill take approximately 15-20 seconds.
9. After scanning you will be brought to the sample results page where you can print, save or share your results.
10. For increased statistical accuracy, the QuantaCann2 can conduct up to 3 tests of a single sample before producing a final analytical report. In order to do this, simply rotate the sample 90-120 degrees between each of the three consecutive scans.

QuantaCann2
Standard Operating Procedure

AK Green Labs LLC

Updated June 2016

1. Potency Analysis Using the QuantaCann2

1.1. Objective

This section provides guidelines for testing marijuana plant material to determine moisture content and the concentrations of the cannabinoids: THC, THCA, CBD and CBDA.

1.2. Equipment

- QuantaCann2
- Mechanical grinder
- Sample cups for test material
- White reference cup
- Cleaning brush, lens cloth

1.3. Procedure

1. Grind raw plant material (dried flower) to the required size (1-2mm).
2. Fill the Sample Cup with fresh-ground flower. Compress it closed with the quartz window facing down and twist to lock the sample cover.
3. Click on the link labeled SCAN to go to the Scan Page.
4. Fill in the form to describe the sample. **Note:** Only "Sample Name" is required; the remaining fields are optional.
5. Click NEXT to go to the Calibration page.
6. Place the White Reference (provided with your system) on the optical scanning area with the white side facing down and click the NEXT button to start the calibration scan. The calibration scan will continue for roughly 30 seconds.
7. After the calibration scan has completed, remove the White Reference, being certain to place it neatly into the protective cover.
8. Place the Sample Cup with test sample, quartz side facing down, into the optical scanning area and click the NEXT button to start the sample scan. The scan swill take approximately 15-20 seconds.
9. After scanning you will be brought to the sample results page where you can print, save or share your results.
10. For increased statistical accuracy, the QuantaCann2 can conduct up to 3 tests of a single sample before producing a final analytical report. In order to do this, simply rotate the sample 90-120 degrees between each of the three consecutive scans.

1.4. Quality Controls

1. **Sample Cups**: Must be cleaned regularly, only with the supplied brush and lens-grade cleaning cloth. Remove any debris from the sample cup using a brush, dampen the cloth with isopropyl alcohol and very gently rub until clean. The optical windows on the instrument should not need regular cleaning and have a thin, anti-reflective coating that is easily scratched or rubbed off. If it is necessary to clean this window, the best procedure is to direct a stream of clean air (eg. "Dust-

Off" or equivalent vapor stream) to blow away dust or debris. Small amounts of dust or debris are not important.

If a more thorough cleaning is required:

a. Remove the window by rotating the window housing by about 45-90 degrees to disengage the magnets that secure the housing to the unit.
b. Carefully lift the window housing off of the instrument base. Use isopropyl or ethanol to gently rinse the window without wiping it and then
c. Blow away any residual liquid with an air stream. As a last resort, very gently dab with an isopropyl-soaked lens

2. **Sample grinder:** Must be thoroughly cleaned with the provided brush between tests. Accumulated sample material from previous scans can degrade the accuracy of results over time. Sample resin build up will require the thorough cleaning and rinsing of the grinder with isopropyl alcohol. It is recommended to soak the interior of the grinder with isopropyl alcohol overnight after each day of testing for optimal results.

1.5 Safety

There are no hazardous materials used in analysis procedure. Standard precautions regarding work with electrical and mechanical devices apply. Detailed information on safe work practices in the laboratory can be found in the AK Green Labs Chemical Hygiene Plan.

Media Article

From: Franklin, Cynthia A (CED)
To: akgreenlabs@gmail.com
Cc: Marijuana Licensing (CED sponsored); Oates, Sarah D (CED)
Subject: Emailing: steep-hill-announces-license-agreement-to-open-cannabis-testing-laboratory-in-the-state-of-alaska-300286798.htm
Date: Wednesday, June 29, 2016 9:26:10 AM
Attachments: image007.png

Dear AK Green Labs,

It appears that after the MCB approved your license with delegation, you have made significant changes to your ownership and have announced that a non-resident corporation is the owner of the license. I am placing your license application on the July 7-8 agenda for the MCB in Fairbanks to discuss this and other changes to your application.

Please plan to attend the meeting so that you can address any questions the board may have.

Thanks,

Cynthia Franklin, Director

Alcohol & Marijuana Control Office

907-269-0351

Steep Hill

Steep Hill Announces License Agreement to Open Cannabis Testing Laboratory in the State of Alaska

License granted to Alaska testing company AK Green Labs LLC

Jun 20, 2016, 10:00 ET from Steep Hill

BERKELEY, Calif., June 20, 2016 /PRNewswire/ -- **Steep Hill**, the global industry leader in cannabis testing and analytics, today announced it has licensed its cannabis testing technologies to a highly-respected team of scientists who have plans to open **Steep Hill Alaska** as a full service cannabis quality assurance laboratory in Anchorage, Alaska, bringing advanced scientific tools and methodology to the state.

"We are very excited to bring **Steep Hill's** industry-leading cannabis testing methods to Alaska. Providing cannabis testing across such a geographically dispersed area like Alaska poses unique challenges, and **Steep Hill**'s innovative hub-and-spoke approach to providing remote testing was among the driving factors in our decision to work with them. Central to this solution is a proprietary system that can provide testing in Alaskan communities that are not on the road system. In addition, this agreement will enable us to bring testing capabilities to Alaska that are far beyond those that are currently available here, such as genetics testing and strain identification. We hope to work with the State Marijuana Control Board to demonstrate the value of these customized, world-class solutions in helping to ensure the safety and proper labeling of cannabis products throughout the entire Alaskan marketplace," said **Steep Hill Alaska** CEO Brian Coyle.

In making the announcement, **Steep Hill** President and CEO Jmîchaele Keller said, "This marks a new era in cannabis safety for the people of Alaska, a geographically challenging state from a testing logistics standpoint. We welcome Brian and his team to the Steep Hill family. We will strongly support his team as they deliver the best science, technology and professionalism available in cannabis testing for patients and adult consumers. We are excited to announce this licensing relationship with an Alaskan-owned lab, an extremely qualified team, and we are eager to work with the Alaska Marijuana Control Board to bring innovative solutions and technology to the Alaska cannabis industry."

Owners of the Steep Hill Alaska lab will be:

- Brian Coyle, MSc, MEng will serve as **CEO of Steep Hill Alaska**. An Alaskan resident, Mr. Coyle brings an extensive background in managing scientific and engineering projects for Oil Industry, Engineering and Scientific Research projects around the world. His recent experience in Alaska, managing field research for the Earthscope Project, required him to travel to the far corners of the state and has provided him with a clear understanding of the logistical challenges of working in Alaska.
- Timothy Hinterberger, PhD, a professor at the University of Alaska Anchorage for 20+ years, brings over 35 years of medical education and molecular biology research experience to **Steep Hill Alaska.**

"We have worked very hard to establish our leadership in the cannabis testing space, and the strength of our new partners in Alaska is a testament to this leadership – together we intend to be the gold standard for science, service and safety for the entire cannabis industry in Alaska," said Keller.

For more information about cannabis testing, please visit the **Steep Hill** website: http://steephill.com

ABOUT STEEP HILL
Founded in California in 2008, **Steep Hill Labs, Inc**. is a science and technology firm that has become the industry leader in cannabis testing and analytics. With labs in five states—soon to be seven with Maryland and now Alaska launching in 2016, along with a new facility in Jamaica—**Steep Hill** is the largest cannabis lab network in the world. The company pioneered the first medical cannabis potency and microbiological contaminants testing methodology for use in California –the first state to legalize medical cannabis. **Steep Hill** has since developed a variety of revolutionary cannabis testing products, including QuantaCann™, QuantaCann2™, GenKit™ and Steep Hill Express™. **Steep Hill** provides expert consulting services to many states, countries and municipalities, and the company is developing proprietary genetic testing, mapping and trademark protection services for the industry as well.

Contact: Cathie Bennett Warner **cell: 415-420-1573** **Email**

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To view the original version on PR Newswire, visit:http://www.prnewswire.com/news-releases/steep-hill-announces-license-agreement-to-open-cannabis-testing-laboratory-in-the-state-of-alaska-300286798.html

SOURCE Steep Hill

Related Links

http://steephill.com

Jun 28, 2016, 08:40 ET

Preview: Steep Hill White Paper Proves Steep Hill Express Meets Accuracy Requirements for Cannabis Flower Potency

Jun 17, 2016, 14:30 ET

Preview: Steep Hill Offers Media Tour of Leading National Cannabis Testing Lab During Arcview and National Cannabis Industry Association Conferences

Read More

Steep Hill

Steep Hill Labs, Inc.
1005 Parker Street
Berkeley, CA 94710
www.steephill.com

June 30, 2016

Cynthia A. Franklin, Director
Alcohol and Marijuana Control Office
The Atwood Building,
550 West 7th Ave., Suite 1600
Anchorage, AK 99501

Dear Ms. Franklin:

I am writing to you in response to your email to Brian Coyle of AK Green Labs LLC, dated June 29, 2016.

First of all, I would like to apologize for any misunderstanding that has arisen from the draft headline of a recent press release issued by Steep Hill. Steep Hill recently signed an agreement with AK Green Labs to provide them with access to Steep Hill's extensive library of cannabis science methods. Access to Steep Hill proprietary technologies - including our real-time LIMS system and our Near-Infrared testing system - and other intellectual property will help AK Green Labs to bring leading edge cannabis science and technology to Alaska.

Please note that the press release published on June 20, 2016 had a draft headline instead of the correct headline. The headline should have read: **Steep Hill Announces Agreement to License Cannabis Testing Technology in the State of Alaska.** The corrected draft was sent to PR Newswire yet the wire service ran with the draft headline, in error. We corrected the mistake with PR Newswire immediately and the correct version of the release is now available online Steep Hill Licenses Cannabis Testing Technology in Alaska and on our website http://landing.steephill.com/alaska .

I would like to make clear the relationship between Steep Hill and AK Green Labs: There is absolutely no ownership in AK Green Labs whatsoever by Steep Hill or any of its officers, directors or employees. Steep Hill is simply the licensor of science, technology and intellectual property to AK Green Labs, in order to help Brian Coyle and his team bring the best cannabis science methods in the industry to Alaska. Brian and his team remain in complete control and full ownership of AK Green Labs.

Please feel free to contact me directly with any further questions you may have regarding this matter, or if we can be helpful to you or the Board in any way. We completely support the role you play in helping to ensure public safety through regulations that are strong and strictly enforced. We apologize if there was any confusion about our role. Thank you for your consideration.

All the Best,

Jmîchaeĺe Keller
President and CEO
Steep Hill Labs, Inc.

(510) 562-7400
jmichaele@steephill.com

Steep Hill Announces Agreement to License Cannabis Testing Technology in the State of Alaska

License granted to Alaska testing company AK Green Labs LLC

Jun 20, 2016, 10:00 ET from Steep Hill

BERKELEY, Calif., June 20, 2016 /PRNewswire/ -- **Steep Hill**, the global industry leader in cannabis testing and analytics, today announced it has licensed its cannabis testing technologies to a highly-respected team of scientists who have plans to open **Steep Hill Alaska** as a full service cannabis quality assurance laboratory in Anchorage, Alaska, bringing advanced scientific tools and methodology to the state.

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Contact: Cathie Bennett Warner **cell: 415-420-1573** **Email**

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SOURCE Steep Hill

Related Links

http://steephill.com

Original MJ-06

(approved at June 9, 2016 meeting)

Alcohol and Marijuana Control Office
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marijuana.licensing@alaska.gov
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Alaska Marijuana Control Board

Operating Plan Supplemental
Form MJ-06: Marijuana Testing Facility

What is this form?

This operating plan supplemental form is required for all applicants seeking a marijuana testing facility license and must accompany the **Marijuana Establishment Operating Plan (Form MJ-01)**, per 3 AAC 306.020(b)(11). Applicants should review **Chapter 306: Article 6** of the **Alaska Administrative Code.** This form will be used to document how an applicant intends to meet the requirements of those regulations. If your business has a formal operating plan, you may include a copy of that operating plan with your application, but all fields of this form must still be completed per 3 AAC 306.020 and 3 AAC 306.615(2).

What additional information is required for testing facilities?

Applicants must identify how the proposed establishment will comply with applicable regulations regarding the following:

- Prohibitions
- Testing practices and procedures
- Employee qualification and training
- Security
- Reporting and records retention

This form must be submitted to AMCO's main office before any marijuana testing facility license application will be considered complete.

Section 1 – Establishment Information

Enter information for the business seeking to be licensed, as identified on the license application.

Licensee:	AK Green Labs LLC	**License Number:**	**10186**		
License Type:	**Marijuana Testing Facility**				
Doing Business As:	**AK Green Labs LLC**				
Premises Address:	**2509 Fairbanks St, Suite A**				
City:	**Anchorage**	**State:**	ALASKA	**ZIP:**	99503

Alcohol and Marijuana Control Office
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Alaska Marijuana Control Board

Operating Plan Supplemental
Form MJ-06: Marijuana Testing Facility

Section 2 – Prohibitions

Applicants should review 3 AAC 306.610 and be able to answer "Agree" to all items below.

The marijuana testing facility will not:	Agree	Disagree
Sell, deliver, distribute or transfer any marijuana or marijuana product to a consumer, with or without compensation	◉	○
Allow any person to consume marijuana or marijuana product on its licenses premises	◉	○

Section 3 – Testing Practices and Procedures

Review the requirements under 3 AAC 306.615, 3 AAC 306.635 – 3AAC 306.645, and 3 AAC 306.660, and identify how the proposed establishment will meet the listed requirements.

Describe each test the marijuana testing facility will offer:

AK Green Labs will initially offer the following tests:

Potency analysis for total THC, total CBD and CBN with optional THCA and CBDA
- Marijuana flower & trim
- Concentrates, extracts & fresh pressed rosin

Microbial screening for E-coli (includes Shiga-toxin producing Escherichia coli) Salmonella, Aspergillus fumigatus, Aspergillus flavus and Aspergillus niger
- Marijuana flower and trim
- Fresh pressed rosin

Foreign matter inspection
- Marijuana flower and trim
- Concentrates, extracts & fresh pressed rosin

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Alaska Marijuana Control Board

Operating Plan Supplemental
Form MJ-06: Marijuana Testing Facility

Standard Operating Procedure Manual (3 AAC 306.640):

Applicants for marijuana testing facilities must have a written procedures manual with detailed instructions explaining how to perform each testing method the applicant or marijuana testing facility uses, and minimum standards for each test. Applicants should be able to answer "Agree" to all items below.

The marijuana testing facility will ensure that the standard operating procedure manual:	Agree	Disagree
Is available to each employee at all times	◉	○
Will cover at least the required procedures listed under 3 AAC 306.640	◉	○

Describe the marijuana testing facility's standard operating procedure for each test the facility will offer:

1) Potency by Gas Chromatography with a Flame Ionization Detector (GC/FID)
This standard operating procedure (SOP) is used for determining the potency of a cannabis product. It describes the methodology whereby herbal products such as flower and leaf, and cannabis concentrates such as shatter, wax, resins and oils, are extracted with an ethanol solution containing an internal standard, and then injected onto a capillary chromatography column whereby individual cannabinoid components are resolved into constituent parts, identified, and quantified by means of a flame ionization detector. This SOP presents options for either reporting potency in terms of total cannabinoid content, e.g., Total THC concentration = concentration of THC + concentration of THCA, or for providing actual cannabinoid concentrations. In the latter method, the actual THC and THCA concentrations, as well as total CBD and CBDA concentrations,are determined by a heat treatment protocol of the extract. Alternatively, a chemical silylation derivative procedure is described and may be utilized. This SOP provides failsafe methods for quantification of THC, THCA, CBD, CBDA and CBN based upon linear calibration curves and regression analysis of the data.

2) Potency by GC/MS
This standard operating procedure is similar to the measurement of potency described above (Test #1) except that a mass spectrometer is employed as a detector rather than a flame ionization detector. Methods are currently being developed for testing pesticide residue with this instrument.

3) Residual Solvent Testing by Head-Space Gas Chromatography with a Flame Ionization Detector (HS/GC/FID)
This standard operating procedure is used for testing residual extraction solvents. These solvents are used in manufacturing concentrated cannabis products such as solids, resins, or oils. The SOP describes how a solid or liquid sample is placed into a sealed vial and then heated at an elevated temperature for a period of time. (Continued on attachment)

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Alaska Marijuana Control Board

Operating Plan Supplemental
Form MJ-06: Marijuana Testing Facility

Laboratory Testing of Marijuana and Marijuana Products (3 AAC 306.645):

A licensed marijuana testing facility must meet minimum standards for laboratory testing. Applicants should be able to answer "Agree" to all items below.

The marijuana testing facility applicant has:

	Agree	Disagree
Read and understands and agrees to the requirements listed under 3 AAC 306.645	◉	○

Describe the acceptable range of results for each test the marijuana testing facility will offer:

All tests offered by AK Green Labs (AKGL) will undergo a technical and managerial review of results in order to ensure the cannabis product meets the acceptable range of results. Duplicate analyses are performed on every customer sample in order to ensure consistency of results. Results must be within 10% relative standard deviation (RSD) of the mean to be accepted. The following tests on cannabis products are offered by AKGL: potency testing, residual solvent testing microbial screening and a visual inspection for foreign matter contaminants. Initially, AKGL will not offer testing of edible cannabis products.

Solvent Contamination
Solvent-extracted concentrates will be tested for residual solvent content, with results expressed in parts per million (ppm). Acceptable limits per gram are: a) Butanes: < 800 ppm; b) Heptanes: < 500 ppm; c) Benzene: < .025 ppm; d) Toluene: < 1 ppm; e) Hexane: < 10 ppm; and f) Total Xylenes (m,p & o-xylenes) < 1 ppm. If a sample exceeds any one of these concentration levels, the sample is failed.

Microbial Screening
If one colony-forming unit of any of the following is detected in a one-gram sample, then the sample is failed: Salmonella, Aspergillus fumigatus, Aspergillus flavus, Aspergillus niger, E-coli (including Shiga-toxin producing Escherichia coli),

Visual Inspection for Foreign Matter
Includes: objectionable matter contributed by insects, rodents, and birds; decomposed material; and miscellaneous matter such as sand, soil, glass, rust, or other foreign substances.
Marijuana flower & trim:
- More than 1 insect part per gram - Fail
- More than 1 human hair per gram - Fail
- Any non-human mammalian hairs or excreta or bird feather - Fail
- More than 5 fragments of miscellaneous matter (sand, soil, etc.) per gram - Fail

Marijuana extracts and concentrates:
- The presence of any insect part, human hair, non-human mammalian hair, excreta, bird feather, or miscellaneous matter (sand, soil, etc.) - Fail

Alcohol and Marijuana Control Office
550 W 7th Avenue, Suite 1600
Anchorage, AK 99501
marijuana.licensing@alaska.gov
https://www.commerce.alaska.gov/web/amco
Phone: 907.269.0350

Alaska Marijuana Control Board

Operating Plan Supplemental
Form MJ-06: Marijuana Testing Facility

Section 4 – Employee Qualification and Training

Review the requirements under 3 AAC 306.625 – 3 AAC 306.630, and identify how the proposed establishment will meet the listed requirements.

Proficiency Testing Program (3 AAC 306.625):

Describe how the marijuana testing facility will ensure the scientific director and all testing analysts are proficient in utilizing testing equipment and analyzing samples:

AK Green Labs employees assigned to GC/FID, HS/GC/FID, and/or GC/MS analyses will be qualified to perform these analytical tests only after passing an internal AKGL training program that instructs on every aspect of the analytical methods described in the Standard Operating Procedure(s). At the end of the training program the analyst must pass an actual analysis test with a "real-life" sample on the equipment he or she has been assigned to before being certified. Internal certifications will be supervised and approved by the Laboratory Director. For training on the operation of specific instruments, analysts and the Laboratory Director (or designate) may be required to attend a manufacturer's training course.

AK Green Labs employees assigned to carry out Microbiological Screening and Visual Inspections will be qualified to perform these tests only after passing an internal training program that instructs on every aspect of the analytical methods described in the Standard Operating Procedure(s). At the end of the training program the analyst must pass an actual analysis test with a "real-life" sample using the appropriate equipment before being certified. Internal certifications will be supervised and approved by the Laboratory Director.

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Alaska Marijuana Control Board

Operating Plan Supplemental
Form MJ-06: Marijuana Testing Facility

Scientific Director (3 AAC 306.630):

All marijuana testing facilities must employ a scientific director with responsibilities and qualifications set out in 3 AAC 306.630 and 3 AAC 306.640(b).

Name the scientific director and describe how he/she meets the qualifications set out in 3 AAC 306.630(b).

Dr. Tim Hinterberger
Education:
1987 Ph.D. in Biology, University of Illinois, Urbana;
1981, M.S. in Biology, University of Illinois, Urbana;
1976 B.S. in Biology, University of Illinois, Urbana
Recent employment:

2013-present	Professor, WWAMI School of Medical Education UAA
2011-2013	Associate Professor, WWAMI School of Medical Education UAA
1998-2011	Associate Professor, Department of Biological Sciences UAA
1992-1998	Assistant Professor, Department of Biological Sciences UAA

(See attachment for full CV)

Section 5 – Security

Review the requirements under 3 AAC 306.650, and identify how the proposed establishment will meet the listed requirements.

Chain of Custody (3 AAC 306.650):

Describe how the marijuana testing facility will meet the chain of custody requirements as listed in this section:

Samples of commercial products must arrive at AKGL in an approved container with a tamper-proof seal, marked with a unique METRC identifier and accompanied by a METRC Manifest. If the seal, the METRC identifier or the Manifest is missing then the sample will not be accepted. Before any analysis is started, the required information will be recorded on the Sample Receiving & Tracking form, entered into the METRC inventory tracking system, and to the AKGL Laboratory Information Management System and the sample placed in the secure storage area. The storage and movement of product samples within the AKGL premises will be tracked on the lower part of the Sample Receiving & Internal Tracking form (see attachment). Samples removed for testing will be noted on this form. Unused sample will be kept in the secure storage are until all requested tests are completed and the results have been reviewed. Marijuana waste and unused samples will be rendered unusable by mixing with used organic solvents and disposed of in the organic wastes barrel, in view of the video surveillance system. (See attached for detailed description of sample receiving and tracking procedure. Waste barrels are discussed in Section 8 of the AKGL Chemical Hygiene Plan)

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Alaska Marijuana Control Board

Operating Plan Supplemental
Form MJ-06: Marijuana Testing Facility

Section 6 – Reporting and Records Retention

Applicants should review 3 AAC 306.670 – 3 AAC 306.675 and be able to answer "Agree" to all items below.

Reporting, Verification (3 AAC 306.670):

The marijuana testing facility applicant:	Agree	Disagree
Has read, understands, and agrees to the reporting requirements outlined in 3 AAC 306.670(a)	◉	○
Has read, understands, and agrees to the reporting requirements outlined in 3 AAC 306.670(b)	◉	○

Records Retention (3 AAC 306.675):

The marijuana testing facility applicant:	Agree	Disagree
Has read, understands, and agrees to the records retention requirements listed in 3 AAC 306.675	◉	○

I declare under penalty of perjury that I have examined this form, including all accompanying schedules and statements, and to the best of my knowledge and belief find it to be true, correct, and complete.

Brian Coyle
Signature of licensee

Brian Coyle
Printed name

Subscribed and sworn to before me this 10th day of May, 2016.

Notary Public
LANCE C. WELLS
State of Alaska
My Commission Expires Jun 18, 2017

Notary Public in and for the State of Alaska.

My commission expires: 6/18/2017

Addendum to Form MJ-06:
Marijuana Testing Facility

AK Green Labs LLC

May 2016

Section 3 – Testing Practices and Procedures

(Continued from page 3 of MJ-06)

Describe the marijuana testing facility's standard operating procedure for each test the facility will offer:

3) Residual Solvent Testing by Head-Space Gas Chromatography with a Flame Ionization Detector (HS/GC/FID)
This standard operating procedure is used to quantitate residual solvents present in solvent-extracted cannabis products. These solvents are used in extracting concentrated cannabis products such as shatter, wax, resins, or oils. The SOP describes how a solid or liquid sample is placed into a sealed vial and then heated at an elevated temperature for a period of time. The heat treatment drives residual solvents from the solid or liquid sample into the gas phase in the head-space above the sample. This gas phase is subsequently sampled from the head-space by means of an airtight gas syringe and then injected onto a capillary chromatography column, which separates and identifies any C1-C6 or BTEX solvents found in the cannabis product by means of a flame ionization detector. Any residual solvent discovered in the sample is quantitated tttttyyyybased upon the linear calibration curves and regression analysis of the data obtained from C1-C6 and BTEX standard reference materials.

4) Microbial Screening
Microbial-growth testing methods are based on the *Bacteriological Analytical Manual* (BAM) of the US Food & Drug Administration: Chapter 4 Enumeration of Escherichia coli and the Coliform Bacteria; Chapter 5 Salmonella; and Chapter 18) Yeasts, Molds and Mycotoxins). This BAM is referenced as the appropriate method for testing microbial loads in *Cannabis Inflorescence: Standards of Identity, Analysis, and Quality Control, Revision 2014*, published by the American Herbal Pharmacopoeia.

The basic procedure is to incubate a 1-gram sample in a nutrient-rich solution for 24 hrs. A small amount of this solution is transferred to agar plates with selective growth agars that discriminate growth of the target bacteria or fungi. These plates are then incubated for 24 - 72 hrs and examined for growth of the target organisms. Additional platings maybe required for positive identification.

5) Visual Inspection for Foreign Materials
Visual inspection will be carried out to look for objectionable matter from insect, rodents, and birds; decomposed material; and miscellaneous matter such as sand, soil, glass, rust, or other foreign substances, as recommended in the *FDA Defect Levels Handbook*. Inspection will be done with a stereoscopic incident-light microscope with magnification up to 50X, equipped for photography of samples.

Microbiological
Standard Operating Procedures

AK Green Labs LLC

Updated May 2016

1. Microbiological Testing

1.1. Objective

This section provides guidelines for microbiological testing of marijuana plant material for the presence of *Escherichia coli, Salmonella* sp., and *Aspergillus fumigatus, Aspergillus flavus,* or *Aspergillus niger*.

1.2. Acceptable Limits

Consistent with 3 AAC 306.645, the presence of one (1) colony-forming unit (CFU) of any of these species detected in a one-gram sample of marijuana shall be deemed unacceptable.

1.3. Microbiological Testing Methods

Microbiological testing methods are based on the *Bacteriological Analytical Manual* (BAM) of the US Food & Drug Administration, chapters 4 (Enumeration of Escherichia coli and the Coliform Bacteria), 5 (Salmonella), and 18 (Yeasts, Molds and Mycotoxins). The BAM is referenced as the appropriate method for testing microbial loads in *Cannabis Inflorescence: Standards of Identity, Analysis, and Quality Control, Revision 2014*, published by the American Herbal Pharmacopoeia.

1.4. Equipment

- Shaking incubator capable of maintaining liquid samples at 35°C± 0.5°C with agitation of 200 to 300 RPM
- Circulating, thermostatically controlled, water bath capable of maintaining liquid samples at 42 ± 0.2°C
- Laboratory pH meter
- Laboratory vortexer
- Cabinet incubators capable of maintaining samples at 35°C± 0.5°C and at 25°C± 0.5°C
- Stereoscopic incident-light microscope with magnification up to 50X, equipped for photography of samples
- Bright-field microscope with magnification up to 1000X for identification of bacteria via Gram-staining

1.5. Procedures

I.5.1 Sample preparation for marijuana inflorescences

Aseptically weigh 1 g sample into sterile, appropriate container. Add 100 ml sterile trypticase soy broth (TSB) and mix well. Cap securely and let stand 60 ± 5 min at room temperature. Mix

well by swirling and determine pH. Adjust pH, if necessary, to 6.8 ± 0.2. Incubate with shaking for 24 ± 2 h at 35°C.

1.5.2 Conventional Method for *E. coli*

To perform the test for *E. coli*, gently agitate incubated sample, streak a 10 µl loopful on a Levine's eosin-methylene blue (L-EMB) agar plate. Incubate for 18-24 h at 35°C± 0.5°C . Examine plates for suspicious *E. coli* colonies, i.e., dark centered and flat, with or without metallic sheen. In order to confirm these as *E. coli* colonies, transfer up to 5 suspicious colonies from each L-EMB plate to plate count agar (PCA) slants, incubate them for 18-24 h at 35°C± 0.5°C and use one of the following methods.

NOTE: Identification of any 1 of the 5 colonies as *E. coli* is sufficient to regard the sample as positive; hence, not all 5 isolates may need to be tested.

Perform Gram stain. All cultures appearing as Gram-negative, short rods should be tested for the IMViC reactions below and also inoculated into Lauryl tryptose broth (LST) to confirm gas production.

Indole production. Inoculate tube of tryptone broth and incubate 24 ± 2 h at 35°C± 0.5°C . Test for indole by adding 0.2-0.3 mL of Kovacs' reagent. Appearance of distinct red color in upper layer is positive test.

Voges-Proskauer (VP)-reactive compounds. Inoculate tube of MR-VP broth and incubate 48 ± 2 h at 35°C± 0.5°C . Transfer 1 mL to 13 × 100 mm tube. Add 0.6 mL α-naphthol solution and 0.2 mL 40% KOH, and shake. Add a few crystals of creatine. Shake and let stand 2 h. Test is positive if eosin pink color develops.

Methyl red-reactive compounds. After VP test, incubate MR-VP tube additional 48 ± 2 h at 35°C± 0.5°C. Add 5 drops of methyl red solution to each tube. Distinct red color is positive test. Yellow is negative reaction.

Citrate. Lightly inoculate tube of Koser's citrate broth; avoid detectable turbidity. Incubate for 96 h at 35°C± 0.5°C. Development of distinct turbidity is positive reaction.

Gas from lactose. Inoculate a tube of LST and incubate 48 ± 2 h at 35°C± 0.5°C. Gas production (displacement of medium from inner vial) or effervescence after gentle agitation is a positive reaction.

Interpretation: All cultures that :

- ferment lactose with gas production within 48 h at 35°C;
- appear as Gram-negative non spore-forming rods, and;
- give IMViC patterns of ++-- (biotype 1) or -+-- (biotype 2).

are considered to be *E. coli*. Calculate MPN of *E. coli* based on proportion of EC tubes in 3 successive dilutions that contain *E. coli*.

1.5.3 Conventional Method for Salmonella

1. Gently agitate incubated sample.
2. Transfer 1 ml of the incubated sample to 10 ml Rappaport-Vassiliadis (RV) medium and another 1 ml mixture to 10 ml tetrathionate (TT) broth. Vortex.
3. Incubate RV medium 24 ± 2 h at 42 ± 0.2°C (circulating, thermostatically controlled, water bath). Incubate TT broth 24 ± 2 h at 35 ± 2.0°C.
4. Mix (vortex, if tube) and streak 3 mm loopful (10 µl) each from incubated TT and incubated RV broth on bismuth sulfite (BS) agar, xylose lysine desoxycholate (XLD) agar, and Hektoen enteric (HE) agar. Prepare BS plates the day before streaking and store in dark at room temperature until streaked.
5. Incubate plates 24 ± 2 h at 35°C.
6. Examine plates for presence of colonies that may be *Salmonella*.

   Pick 2 or more colonies of *Salmonella* from each selective agar after 24 ± 2 h incubation. Typical *Salmonella* colonies appear as follows:

   a. **Hektoen Enteric (HE) agar.** Blue-green to blue colonies with or without black centers. Many cultures of Salmonella may produce colonies with large, glossy black centers or may appear as almost completely black colonies.

   b. **Xylose Lysine Desoxycholate (XLD) agar**. Pink colonies with or without black centers. Many cultures of Salmonella may produce colonies with large, glossy black centers or may appear as almost completely black colonies.

   c. **Bismuth Sulfite (BS) agar**. Brown, gray, or black colonies; sometimes they have a metallic sheen. Surrounding medium is usually brown at first, but may turn black in time with increased incubation, producing the so-called halo effect.

If typical colonies are present on the BS agar after 24 ± 2 h incubation, then pick 2 or more colonies. Irrespective of whether or not BS agar plates are picked at 24 ± 2 h, reincubate BS agar plates an additional 24 ± 2 h. After 48 ± 2 h incubation, pick 2 or more typical colonies, if present, from the BS agar plates, only if colonies picked from the BS agar plates incubated for 24 ± 2 h give atypical reactions in triple sugar iron agar (TSI) and lysine iron agar (LIA) that result in culture being discarded as not being Salmonella. See sections below for details in interpreting TSI and LIA reactions.

In the absence of typical or suspicious *Salmonella* colonies, search for atypical *Salmonella* colonies as follows:

d. **HE and XLD agars.** Atypically a few Salmonella cultures produce yellow colonies with or without black centers on HE and XLD agars. In the absence of typical Salmonella colonies on HE or XLD agars after 24 ± 2 h incubation, then pick 2 or more atypical Salmonella colonies

e. **BS agar.** Atypically some strains produce green colonies with little or no darkening of the surrounding medium. If typical or suspicious colonies are not present on BS agar after 24 ± 2 h, then do not pick any colonies but reincubate an additional 24 ± 2 h. If typical or suspicious colonies are not present after 48 ± 2 h incubation, then pick 2 or more atypical colonies.

Lightly touch the very center of the colony to be picked with a sterile inoculating needle and inoculate Triple Sugar Iron agar (TSI) slant by streaking slant and stabbing butt. Without flaming, inoculate Lysine Iron gar (LIA) slant by stabbing butt twice and then streaking slant. Since lysine decarboxylation reaction is strictly anaerobic, the LIA slants must have deep butt (4 cm). Store picked selective agar plates at 5-8°C.

7. Incubate TSI and LIA slants at 35°C for 24 ± 2 h. Cap tubes loosely to maintain aerobic conditions while incubating slants to prevent excessive H_2S production. *Salmonella* in culture typically produces alkaline (red) slant and acid (yellow) butt, with or without production of H_2S (blackening of agar) in TSI. In LIA, *Salmonella* typically produces alkaline (purple) reaction in butt of tube. Consider only distinct yellow in butt of tube as acidic (negative) reaction. Do not eliminate cultures that produce discoloration in butt of tube solely on this basis. Most *Salmonella* cultures produce H_2S in LIA. Some non-*Salmonella* cultures produce a brick-red reaction in LIA slants.
8. All cultures that give an alkaline butt in LIA, regardless of TSI reaction, should be retained as potential *Salmonella* isolates and submitted for biochemical and serological tests. Cultures that give an acid butt in LIA and an alkaline slant and acid butt in TSI should also be considered potential *Salmonella* isolates and should be submitted for biochemical and serological tests. Cultures that give an acid butt in LIA and an acid slant and acid butt in TSI may be discarded as not being *Salmonella*. Test retained, presumed-positive TSI cultures as directed in D-11, below, to determine if they are *Salmonella* species, including *S. arizonae*. If TSI cultures fail to give typical reactions for *Salmonella* (alkaline slant and acid butt) pick additional suspicious colonies from selective medium plate not giving presumed-positive culture and inoculate TSI and LIA slants as described above.
9. Apply biochemical and serological identification tests to:

a. Three presumptive TSI cultures recovered from set of plates streaked from RV medium, if present, and 3 presumptive TSI agar cultures recovered from plates streaked from TT broth, if present.

b. If 3 presumptive-positive TSI cultures are not isolated from one set of agar plates, test other presumptive-positive TSI agar cultures, if isolated, by biochemical and serological tests. Examine a minimum of 6 TSI cultures for each 1 g analytical unit.

1.5.4 Identification of *Salmonella*

1. **Mixed cultures.** Streak TSI agar cultures that appear to be mixed on MacConkey agar, HE agar, or XLD agar. Incubate plates 24 ± 2 h at 35°C. Examine plates for presence of colonies suspected to be *Salmonella*.

   - MacConkey agar. Typical colonies appear transparent and colorless, sometimes with dark center. Colonies of *Salmonella* will clear areas of precipitated bile caused by other organisms sometimes present.
   - Hektoen enteric (HE) agar. See D-7a, above.
   - Xylose lysine desoxycholate (XLD) agar. See D-7b, above. Transfer at least 2 colonies suspected to be *Salmonella* to TSI and LIA slants as described in D-7, above, and continue as in D-9, above.

2. **Pure cultures.** Urease test (conventional). With sterile needle, inoculate growth from each presumed-positive TSI slant culture into tubes of urea broth. Since occasional, uninoculated tubes of urea broth turn purple-red (positive test) on standing, include uninoculated tube of this broth as control. Incubate 24 ± 2 h at 35°C.

3. **Control cultures.** In addition to the positive control cultures (typical *Salmonella*), three additional *Salmonella* cultures are recommended to assist in the selection of atypical *Salmonella* colony morphology on selective agars. These cultures are a lactose-positive, H_2S-positive *S. diarizonae* (ATCC 12325) and a lactose-negative, H_2S-negative *S. abortus equi* (ATCC 9842); **OR** a lactose-positive, H_2S-negative *S. diarizonae* (ATCC 29934). These cultures may be obtained from the American Type Culture Collection, 10801 University Boulevard, Manassas, VA 20110-2209

1.5.5 Conventional method for Aspergillus

Gently agitate the incubated sample. Transfer 0.1 ml on Dichloran rose bengal chloramphenicol (DRBC) agar plates and spread inoculum with a sterile, bent glass rod. Incubate plates in the dark at 25°C. Do not stack plates higher than 3 and do not invert. **Note:** Let plates remain undisturbed until counting.

1. **Counting of plates.** Count plates after 3 days of incubation. If there is no growth, re-incubate for another 48 h. Do not count colonies before the end of the incubation period because handling of plates could result in secondary growth from dislodged spores, making final counts invalid.

Mold colonies suspected of being *Aspergillus* sp. are examined microscopically to observe diagnostic features of *Aspergillus fumigatus*, *Aspergillus flavus*, and *Aspergillus niger*. Identification will be based on: Larone, D. H. 1995. *Medically important fungi: a guide to identification*, 3rd ed. ASM Press, Washington, D.C

2. **Colony characteristics**

A. fumigatus	2.5–8 µm wide, septate, hyaline, acute angle branching, tree- or fan-like branching. Stipes may resemble hyphae of zygomycetes	Conidial head uniseriate, columnar, conidia in chains or detached and dispersed. Single or paired conidia may resemble yeast cells
A. niger	See *A. fumigatus*	Conidial head biseriate, radiate, conidia in chains or detached and dispersed. Single or paired conidia may resemble yeast cells

Colonies characteristic of *Aspergilllus* but not identifiable as *A. fumigatus* or *A. niger* will be transferred to *Aspergillus* differentiation agar (AFPA), a selective identification medium for the detection of *A. flavus* group strains. With this method is possible to distinguish these species from other *Aspergillus* based on the development of orange color on the reverse of the plates.

1.6. Quality Controls

1. **Negative Controls.** Controls to assure that any observed microbial growth originates from the received sample will be conducted daily.
2. **Positive Controls.** Controls to assure that the protocols described are sufficient to detect the appropriate organisms when present will be conducted every 3 months, or whenever media and reagents are purchased from a different supplier than any whose materials have been previously tested.

1.7 Safety

Additional information on safe work practices in the laboratory can be found in the AK Green Labs Chemical Hygiene Plan.

1. **Treat all microorganisms as potential pathogens.** While the majority of microorganisms are not pathogenic to humans and have never been shown to cause illness, under unusual circumstances a few microorganisms that are not normally

pathogenic can act as pathogens. Treat all microorganisms - especially unknown cultures - as if they were pathogenic.

2. **Sterilize equipment and materials.** All materials, media, tubes, plates, loops, needles, pipetes, and other items used for culturing microorganisms should be sterilized by autoclaving. Otherwise, use commercially sterilized products.

3. **Disinfect work areas before and after use.** Use a disinfectant, such as a 10% bleach or 70% ethanol solution, to wipe down benches and work areas both before and after working with cultures. Also be aware of the possible dangers of the disinfectant, as 70% ethanol can catch fire around open flame or high heat sources. Bleach, if spilled, can ruin your clothing. Either alcohol or bleach can be dangerous if splashed in the eyes. Employees should know where the nearest eyewash station and sink are located.

4. **Wash your hands.** Use a disinfectant soap to wash your hands before and after working with microorganisms. Gloves may be worn as extra protection.

5. **Never pipette by mouth.** Use pipette bulbs or pipetting devices for the aspiration and dispensing of liquid cultures.

6. **Do not eat or drink in the lab, nor store food in areas where microorganisms are stored.** Never eat or drink in the laboratory while working with microorganisms. Keep your fingers out of your mouth, and wash your hands before and after the laboratory activity.

7. **Label everything clearly.** All cultures, chemicals, disinfectant, and media should be clearly and securely labeled with their names and dates. If they are hazardous, label them with proper warning and hazardous information.

8. **Clean up spills with care.** Cover any spills or broken culture tubes with a 70% ethanol or 10% bleach solution; then cover with paper towels. After allowing the spill to sit with the disinfectant for a short time, carefully clean up and place the materials in a biohazard autoclave bag to be autoclaved. Wash the area again with disinfectant. **Never** pick up glass fragments with your fingers or stick your fingers into the culture itself; instead, use a brush and dustpan.

Chromatography
Standard Operating Procedures

AK Green Labs LLC

Prepared by:	Dr. Benjamin Mattes
Date:	May 2016
Version:	5.2

Table of Contents

1. SCOPE AND OBJECTIVES

1.1 Scope

The Standard Operating Procedures presented in this document will be used by AK Green Labs LLC (AKGL) to analyze cannabis and cannabis products, including: marijuana flowers and trim, wax, shatter, resin and oil.

1.2 Objectives

The primary goal of AKGL is to carry out high-quality analyses to quantitate potency and solvent contamination of marijuana and marijuana products. These quantities must be determined, and the values must fall within the acceptable limits set by the Alaska State Regulations before marijuana products can enter the retail marketplace.

A second goal is to perform these analyses as quickly and efficiently as possible with available resources. To this end, samples will be, analyzed, documented and reviewed based upon the following objectives:

1.2.1 All samples shall be analyzed as soon as practical after they are received. If the analysis, including technical and administrative review, cannot be completed in the time quoted to customer, an attempt will be made to notify the customer using the information provided upon submission of the sample, as to when the analysis will be completed.

1.2.2 Fifty percent of all samples should be analyzed and completed within two weeks.

1.2.3 All samples should be analyzed and completed within thirty days.

1.2.4 All reports should be produced as soon as possible after the completion of analysis but within two working days.

1.2.5 Sample files and the analysis report should be technically and administratively reviewed within five working days following the production of the analysis report.

2. ANALYSIS GUIDELINES

2.1 Objective

To describe a basic analytical scheme, utilizing toxicity tests, extraction techniques, and instrumental analytical procedures, for the isolation and identification of cannabis products and possible contaminants.

2.2 Safety

2.2.1 Use caution when handling any unknown substance or chemical.

2.2.2 For hazardous materials, or possible hazardous materials, use appropriate personal protective equipment.

2.2.3 Use proper lifting techniques and caution when handling heavy items.

2.2.4 Use caution and proper technique when using sharp instruments to cut into packaging.

2.2.5 Make frequent reference to the AKGL Chemical Hygiene Plan.

2.3 Basic Analytical Scheme for Flower, Trim, Extracts and Concentrates

The customer may request specific analyses for cannabis products. However, the analyst must determine the appropriate sampling techniques, methods of recovery, extraction procedures, and methods of analysis to be used for the identification and quantification of a cannabis product on a case-by-case basis.

2.3.1 Data Required for Chromatography Analyses

Maintenance and quality assurance procedures are documented and available next to each instrument. It is the analyst's responsibility to verify that an instrument is working properly before use.

The data generated from an instrumental method must be documented with the METRC identifier, the AKGL LIMS number, and the analyst's handwritten initials. The date on the printouts will serve as the date of observation unless otherwise noted by the analyst. The following should also be documented:

2.3.2 GC/FID AND HS/GC/FID

All appropriate information regarding sample preparation, retention times, weights, or calculations will be documented on the GC/FID printouts or in the customer case file. Documentation of internal standard runs will be maintained with the customer case file. Blanks run prior to the internal standard and sample runs will be maintained with the customer case file.

2.3.3 GC/MS

All appropriate information regarding sample preparation, retention times, weights, TIC, or calculations will be documented on the GC/MS printouts or in the customer case file. Documentation of internal standard runs will be maintained with the customer case file. Blanks run prior to the internal standard and sample runs will be maintained with the customer case file.

2.4 Records Retention

All customer case file records will be retained as hard copies onsite for a minimum of 3 (three) years. A electronic copy of the customer case file records over two years old will be saved and backed up locally.

2.5 Marijuana Plant Material

Marijuana samples received for analysis can be whole plants or plant parts. The most common plant parts that will be submitted for analysis are flowers (buds) and trim (sugar leaves). Plant materials are typically dried prior to analysis, with the before and after drying weights recorded. The weight recorded for dried plant parts will be noticeably less than the listed weight as submitted by the customer

2.5.1 For whole plant sample submissions, remove roots, dirt and mature stalks before weighing. Mature stalks are the main axis of the plant, fluted in appearance, and are greater than ~1 centimeter in diameter or larger. Stems are also fluted in appearance and serve as a support structure for another part of the plant such as a leaf or flower and should be removed.

2.6 Marijuana Concentrates and Extracts

Marijuana concentrates and extracts can be produced by many different processes including: extraction by organic solvents (butane, ethanol etc), extraction with CO2 as solvent, concentration by mechanical methods (keif, hash, pressed rosin), or a combination of these methods.

No special handling is required for samples of these products with the exception of the fresh pressed rosin. Samples of fresh pressed rosin should be kept refrigerated in the sample storage area until ready for analysis

3. CUSTOMER CASE DOCUMENTATION

3.1 Objective

The policies laid out in this section are the minimum requirements for customer case documentation and record keeping required for AKGL.

3.2 Case Folders

A Case Folder will be created for each sample analyzed. For frequent or high-volume customers, we may organize their sample Case Folders into Customer Case Folders for easier reference. Contents of the Case Folders may also be archived electronically.

3.2.1 Case Folders will contain the AKGL Sample Receiving and Tracking form as well as any other forms used to receive, prepare and track the samples. Case Folders will also contain the AKGL forms used to record the analyses; forms that are described in this document as well as those referred to in the Microbial Standard Operating Procedures. Reports of analysis results will be kept in these folders and will include the analyst's name, title, and signature as well as a record of the technical and administrative review.

3.2.2 Charts, chromatographs, spectra, and notes produced during the analytical procedures will be maintained with the case file

3.2.3 Photographs should printed on 8 ½" by 11" paper and labeled with the METRC case identifier and LIMS item designators, the date the photos were taken, and the analyst's handwritten initials. Photographs may also be maintained electronically as part of the case record.

3.2.4 Sample blanks run directly prior to any case samples on the GC/FID, HS/GC/FID or GC/MS, will be maintained with the case file.

3.2.5 Other relevant information should also be included, e.g. notes on customer contacts, phone calls and emails, or any unusual circumstance pertaining to the sample. Alternatively, these may be documented electronically as part of the case record.

3.3 Administrative Review

All case files will be administratively reviewed by an individual other than the author of the report prior to issuance of the report. An administrative review requires the following verification steps.

3.3.1 Verify that both the METRC identifier and the AKGL LIMS number are correct for the customer case being reviewed.

3.3.2 Check spelling, grammar, METRC identifier, the AKGL LIMS number, and the analyst's

name and title.

3.3.3 Verify that the correct information is listed for the inventoried Cannabis Product.

3.3.4 The completed administrative review is indicated on the final report with the reviewer's name, title, and signature. The date of the completed administrative review is electronically documented in the LIMS and METRC.

3.4 Technical Review

Analysis reports will be technically reviewed before by a person other than the author of the report before an analysis is deemed complete and the. This review will be carried out by the Scientific Director or designate, and will include the following:

3.4.1 Verify that the weights on the report match the weights on the **Cannabis Product Examination Sheet**. Check that the weights on the **Sample Receiving and Tracking** form are consistent with the reported weights.

3.4.2 Verify that all chromatographs and spectra support the conclusion.

3.4.3 Verify that all chromatographs and spectra contain the appropriate unique customer METRC number and LIMS designator.

3.4.4 Verify that all chromatographs and spectra contain any pertinent documentation and that the chromatographs and spectra are documented on the **Cannabis Product Examination Sheet**. Check for the presence of any necessary blanks.

3.4.5 All **Cannabis Product Examination Sheet(s)** and chromatographs and spectra must have the analyst's handwritten initials.

3.4.6 Verify that all observations listed on the **Cannabis Product Examination Sheet(s)** are consistent with the conclusion(s).

3.4.7 The completed technical review is indicated on the final report with the reviewer's name, title, and signature. The date of the completed technical review is electronically documented in a retrievable format.

3.4.8 Before giving any verbal results to a requestor (for example, priority, rush, or customers' cases) the analysis will be technically reviewed and the technical review will be documented as part of the customer case record. The results of analysis still need to be included in the official report.

3.5 Administrative and Technical Review Issues

To ensure the quality of a final report, any significant issues discovered by a technical reviewer (such as reporting a wrong weight, a wrong internal standard, reporting results

without sufficient tests, etc.) must be reported to the Laboratory Director or designee, in person, as soon as possible. Administrative review issues should also be reported if it becomes an analyst's pattern.

3.6 Customer Report Modification Records

3.6.1 It is sometimes necessary to modify a customer report after it has been issued. This may be necessary to correct an error in the report, to document additional analysis conducted after the issuance of the report, at the request of the customer, or for various other reasons.

3.6.2 If it becomes necessary to amend a signed report, then the new report will be clearly identified, will contain a reference to the original report that it is replacing, and will clearly state why an amended report was issued. The original customer report must be maintained within the case record.

3.7 Related Documents

3.7.1 CANNABIS PRODUCT Examination Sheet (AKGL ES-EXAM)

3.7.2 CANNABIS PRODUCT Inventory Sheet (AKGL-IS-INV)

3.7.3 CANNABIS PRODUCT Notes Sheet (AKGL-NS-NOTES)

3.7.4 CANNABIS PRODUCT Checklist Sheet (AKGL-CS-CHECK)

4. CANNABIS PRODUCT WORKSHEETS

4.1 Objective

To provide guidelines for documentation of tests and observations on the CANNABIS PRODUCT Examination Sheet, the CANNABIS PRODUCT Notes Sheet, and the CANNABIS PRODUCT Checklist.

4.2 Cannabis Product Examination Sheet

4.2.1 Customer Case Information

Case – This is the unique case Metrc identifier, which may be an historic lab number, for repeat customers, and the LIMS customer identifier.

Date – This is the start date of analysis.

The date for observations that do not have printed data will be documented appropriately if different than the start date. The date on printouts will serve as the date of observation unless otherwise noted by the analyst.

Analyst – Placement of initials in this box indicates the person(s) who performed or observed all of the analysis documented. If an analyst only performs or observes a portion of the analysis, then his/her initials will be noted next to the results for that test.

Item Number – The LIMS generated item/sub-item number for the exhibit(s).

Description – A brief description of the general appearance of material shall be entered here This is intended to assist the analyst and reviewer with correlating the documentations noted here with the evidence as described on the **CANNABIS PRODUCT Inventory Sheet**. This is not a required field, but may be used at the analyst's discretion.

4.2.2 Analytical Documentation

No acceptable match (or NAM) should be noted when the sample produces a measurable absorbance, but the spectra cannot be matched to a standard or known substance. This may be due to a significant wavelength shift from expected peak maxima, or interferences from other absorbing substances, which cause extraneous peaks or peak shape distortions.

GC/FID – Document the quantitation value obtained.

HS/GC/FID – Any identified substances which are to be included on the final report will be noted in the HS/GC/FID box. This includes: BTEX or residual solvents.

GC/MS - Any identified substances which are to be included on the final report will be noted in the GC/MS box.

Approximate Volume – The approximate volume will be noted for liquids identified as containing cannabis. The approximate volume for other liquids may also be noted.

Gross Weight – Notations of the gross weight will refer to the cannabis product(s) and the inner most container(s) unless otherwise noted.

Total Net Weight – This refers to the total net weight of all cannabis product(s) as designated by the item number. It does not include packaging.

Balance(s) Used – Indicates which balance(s) were used for any weight determinations.

Results - The results of the analysis, which are to be reported are noted in this box.

4.2.3 When a case is reopened and further analysis is required, a new **CANNABIS PRODUCT Examination Sheet** should be used following the guidelines outlined above

4.3 Cannabis Product Checklist

Case – This is the unique, METRC customer number.

Date – This is the date that observations are made. Any observations on a different date than this will be documented accordingly next to the corresponding item number.

Analyst – Placement of initials indicates the person(s) who made the observations documented.

Item – The customer case LIMS number generated item/sub-item number for the case.

Characteristics – A check mark and the number of samples is placed in each box for the characteristics that are observed. If there are no characteristics observed for a sample, then this will be noted in the appropriate box.

4.4 Related Documents

4.4.1 CANNABIS PRODUCT Examination Sheet (AKGL-CP-EXAM)

4.4.2 CANNABIS PRODUCT Inventory Sheet (AKGL-CP-INV)

4.4.3 CANNABIS PRODUCT Notes Sheet (AKGL-CP-NOTES)

4.4.4 CANNABIS PRODUCT Checklist (AKGL-CP-MARI)

5. INSTRUMENT PERFORMANCE AND MAINTENANCE

5.1 Objective

The following describes quality assurance guidelines for the maintenance, performance, and repair of analytical instrumentation and other related equipment.

5.2 General Requirements for Analytical Instrumentation

5.2.1 All instruments will be verified before being placed into service and will be periodically maintained in accordance with the manufacturer's recommendations and specifications.

5.2.2 The performance of all instruments will be re-verified if they are moved to a new location, or if a major repair is performed. It is the analyst's responsibility to ensure that appropriate re-verification has been done before using an instrument for analysis.

5.2.3 No instrument is to be used if it is not in proper working order. If an instrument fails calibration or a performance verification check, or if a performance problem is detected during an analysis run, the instrument will be removed from service.

5.2.4 If an instrument is taken out of service, it will be marked *Out Of Service* and the Laboratory Director or designee will be notified. and determine if repairs are necessary, then notified.

5.2.5 Records of all repairs and maintenance will be maintained in the appropriate laboratory equipment records section.

5.3 Gas Chromatography/Flame Ionization Detector (GC/FID)

5.3.1 A performance verification check will be done daily for any operational GC instrument in service. This can be performed through the use of check standards of known concentration. The mean concentration of these check standards will be calculated from three injections and the % relative standard deviation must be equal to or less than 10%. In addition the % difference of the mean from the known concentration must be equal to or less than 10%.

5.3.2 Determine if the instrument meets specifications. If it does not, then the instrument will be taken out of service until the issue can be resolved.

5.3.3 Maintain a record of all performance verification checks in the Instrument's Logbook.

5.3.4 Run a solvent blank before all other runs and maintain a copy of the blank run with the case file.

5.3.5 Perform regular and preventive maintenance according to the manufacturer's

recommendations. A logbook documenting all non-routine maintenance (e.g., column replacement and any major repairs) will be kept with the instrument.

5.4 Gas Chromatography/Mass Spectrometry (GC/MS)

5.4.1 The Mass Selective Detector (MSD) will be tuned weekly when in use or more often as needed (e.g. if the instrument is moved to a new location or maintenance is performed on the MSD). Criteria established by the vendor will be referenced for a successful tune. It is recommended that specifications used to check the instrument performance be kept next to the instrument for easy reference.

5.4.2 A standard check mix will be run daily when in use and the scan results entered in the logbook and maintained with the tune report for that week. If there is any deviation of the standard m/z ratios, the instrument will be tuned and the standard re-run.

5.4.3 Printed copies of tune records and daily check mix results are maintained in the section.

5.4.4 Run a solvent blank before each sample run and maintain a copy of the blank run with the case file.

5.4.5 Perform regular and preventive maintenance according to the manufacturer's recommendations. A logbook documenting all maintenance (e.g. column replacement, filament replacement, seal replacement, vacuum oil changes, source cleaning, and major repairs) will be kept with the instrument.

5.5 Balances

5.5.1 Laboratory personnel will check balances for accuracy regularly, using standard weights. Balances must be checked whenever they are moved from one location to another. Laboratory standard weights should be checked after the annual re-certification of the balance.

5.5.2 Balances will be certified by an external vendor at least once a year.

5.5.3 Inspect the balances for cleanliness and check the level frequently.

5.5.4 The appropriate balance will be used for the weight being measured and precision required. Care should be taken not to overload a balance with too much weight.

5.5.5 Since the tolerances of electronic balances vary, the instrument specifications must be checked to determine the appropriate criteria for satisfactory performance.

5.5.6 Analytical balances should be checked with standard weights at least weekly.

5.5.7 Top loading balances should be checked with standard weights monthly or as needed.

5.5.8 Records documenting the results of the balance checks, standard weight checks,

maintenance, and certification will be maintained in the appropriate lab section.

5.5.9 It is the analyst's responsibility to verify that the necessary checks have been performed in the recommended time period for any balances or standard weights used.

5.5.10 If an instrument or balance fails the performance check or a performance problem is detected during routine maintenance, it must be removed from service, the Laboratory Director or designee must be notified and the problem recorded.

5.5.11 No instrument or balance is to be used if it is not in proper working order.

5.5.12 Repair or have the instrument or balance repaired and perform routine quality control procedures with standard weights to ensure it is working properly before the instrument or balance is returned to service. Verification with standard weights will be performed after routine maintenance if the performance of the instrument could be affected.

5.6 Related documents

Instrument Logbooks

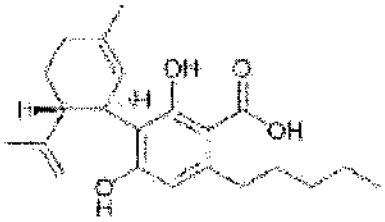
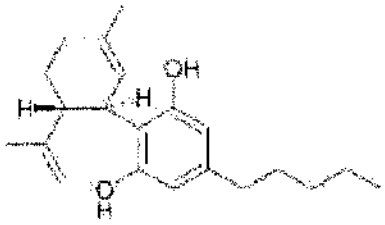
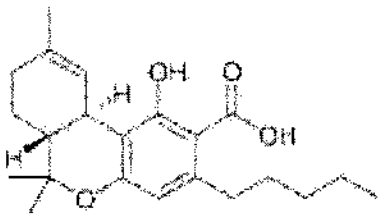
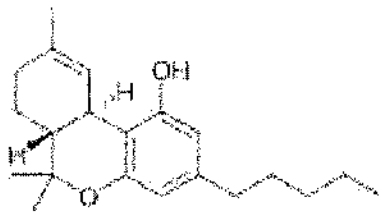
6. GAS CHROMATOGRAPHY (GC/FID) FOR QUANTITATION OF POTENCY

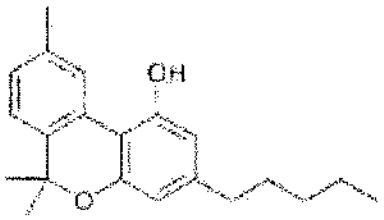
6.1 Objective

To establish a procedure for determining the concentration of cannabinoids in marijuana samples using an internal standard and gas chromatography/flame ionization detection (GC/FID) method.

6.2 Background

6.2.1 The chemical structures and a brief description of the cannabinoids to be quantitated are given in the following figure:

	**Cannabidiolic Acid** (CBDA), an acid with the carboxylic group (COOH) attached, is a precursor to Cannabidiol. When the carboxyl group is removed the CBDA converts to CBD.
	**Cannabidiol** (CBD), an isomer of THC, is a non-psychoactive cannabinoid with sedative, anti-anxiety, anti-psychotic qualities known to relieve convulsion, fight inflammation, assuage nausea, and may even inhibit the growth of some types of cancer cells.
	***Delta*-9-Tetrahydrocannabinol Carboxylic Acid** (Δ9-THC-A, THCA), an acid with the carboxylic group (COOH) attached. It is only when the carboxyl group is removed through decarboxylation that THC becomes psychoactive (heat treatment).
	**Delta-9-Tetrahydrocannabinol** (Δ9-THC, THC) is the primary psychoactive component of the plant.

	**Cannabinol** (CBN), is a cannabinoid derived from the degradation of THC over time and, when properly measured, can help determine both the freshness of samples and their level of psycho-activity.

6.2.2 Whether or not derivatization is required depends on the purpose of the analysis. Without prior derivatization (i.e. silylation) of THC and THCA, GC analysis will decarboxylate the latter and produce the total THC content of the cannabis sample, which is the sum of free THC and THC generated from THCA. As the total THC content represents the maximum potency of the usually smoked (and therefore also decarboxylated) cannabis, most legal systems consider total THC content as the relevant parameter. However, if both contents have to be reported, prior derivatization is required or a separate analysis (e.g. by HPLC/PDA) must be performed.

6.2.3 For a potency test on cannabis and cannabis extracts,test results will be reported by listing for each required cannabinoid a single percentage concentration that represents an average of all samples within the test batch; alternatively, the sum of THC + THCA may be reported as total THC; the sum of CBD + CBDA may be reported as total CBD.

6.2.4 For a potency test on cannabis products, whether conducted on each individual production lot or using process validation, test results will be reported by listing for each cannabinoid the herbal number of milligrams (total THC, total CBD, and CBN) continued within a single retail marijuana product for sale.

6.3 Training

AKGL employees assigned to carry out GC/FID analyses will be qualified to perform these analytical tests only after passing an internal AKGL training program that instructs on every aspect of the analytical methods described in this document. At the end of the training program the analyst must pass an actual analysis test with a "real-life" sample on the GC/FID equipment before being certified. Internal certification will be supervised and approved by the Laboratory Director.

6.4 Safety

Appropriate safety equipment should be used when preparing reagents and handling volatile chemicals. Refer to the MSDS for additional safety information for specific

chemicals. Recommended procedures for a safe working environment and additional information on working safely in the laboratory and can be found in the AKGL Chemical Hygiene Plan.

6.5 Equipment, Materials and Reagents

6.5.1 Gas chromatograph equipped with a flame ionization detector

6.5.2 Auto-sampler vials and caps

6.5.3 Injection syringe

6.5.4 Analytical balance needed for quantitation

6.5.5 Micro-Pipettes and Dispenser Tips (1-100 **µL** 1-1,000 **µL**)

6.5.6 Suitable solvents for sample preparation, e.g.Ethanol

6.5.7 THC, CBD, and CBN standards

6.5.8 Tribenzylamine (TBA) to be used as internal standard

6.6 Standards, Controls and Calibration

A valid five point linearity plot using cannabis base standards mixed with internal standard will be determined for the instrument. If major instrument repairs (e.g. replacement of the column or detector) are performed or if a fresh internal standard solution is prepared, the linearity will be re-confirmed.

6.6.1 Internal Standard Solutions

Internal standard solutions will be prepared by dissolving the aromatic amine Tribenzylamine (TBA) in ethanol (EtOH). The final concentration of the internal standard should be approximately 0.5 mg per mL of EtOH. If a fresh internal standard is prepared, then all standards and samples must be prepared using the new solution.

6.6.1.1 If the internal standard stock solution is stored for later use, it should be well sealed and not exposed to extreme temperatures. It will be labeled with the name of the internal standard, date of preparation, initials of the analyst who prepared the solution and the final concentration. The preparation of internal standard solution will be documented on the **GC/FID Internal Standard Preparation** worksheet and added to the GC/FID Quantitation Binder located next to the instrument.

6.6.1.2 An injection of internal standard solution will be made prior to each linear plot determination, each batch of check standard runs, and prior to case samples to verify that the internal standard is free of contamination. The internal standard blanks will be run on

the same method as standards and samples.

6.6.2 Linearity Plot

Five cannabinoid base calibration standards (THC, THCA, CBD, CBDA, and CBN) of known concentration (in units of mg/mL) will be prepared over the range of interest using the internal standard solution and will be used to generate the linearity plot. The calibration standards will be labeled with the name and concentration of the solution, date of preparation, and the initials of the analyst who prepared them. The preparation of calibration standards will be documented on the **GC/FID Calibration Standards Preparation** worksheet and added to the Quantitation Binder located next to the instrument.

6.6.2.1 The calibration standard of lowest concentration will define the method's lower limit of quantitation (LLOQ). The calibration standard of high concentration will define the upper limit of quantitation (ULOQ).

6.6.2.2 Each calibration standard will be injected one time. All instrument conditions must remain constant over the range.

6.6.2.3 A plot of response ratio (calibration standard area/internal standard area) on the y-axis vs. concentration ratio (calibration standard concentration/ internal standard concentration) on the x-axis will be generated using linear regression. The plot of the fit must appear linear. The correlation coefficient (R^2) must be greater than or equal to 0.99.

6.6.2.4 If the correlation coefficient is less than 0.99, then appropriate corrective action must be taken. This may include: rerunning the calibration standards, remaking the calibration standards, or performing instrument maintenance.

6.6.2.5 If the correlation coefficient is acceptable, then the completed **GC/FID Linear Plot Calibration** worksheet will be added to the Quantitation Binder located next to the instrument. Document the calibration runs in the instrument logbook.

6.6.3 Check Standards

Two cannabis base check standards of known concentration (in units of mg/mL) will be prepared within the linear calibration range using the internal standard solution. One check standard should be in the upper calibration range and one check standard should be in the lower calibration range. The check standards should be labeled with the name and concentration of the solution, date of preparation, and the initials of the analyst who prepared them. The preparation of check standards will be documented on the **GC/FID**

Check Standards Preparation worksheet and added to the Quantitation Binder located next to the instrument.

6.6.3.1 Both check standards will be analyzed following the determination of a linear plot and once daily prior to instrument use for sample analysis. Both check standards will be injected at least two times.

6.6.3.2 The concentration of each check standard injection will be calculated using the linear regression equation from the linear plot.

6.6.3.3 The mean and % relative standard deviation (% RSD) of the concentrations will be calculated for both of the check standards. The % RSD (the precision) must be equal to or less than 10% for both check standards.

6.6.3.4 The % difference (accuracy) of the mean from the known concentration (theoretical) of both check standards will be calculated. Each value (the accuracy) must be equal to or less than 10%.

% difference (Accuracy) = (Calculated – Theoretical * 100)/Theoretical

6.6.3.5 If the % difference and %RSD of the check standard concentrations do not meet the listed criteria, then appropriate corrective action must be taken. This may include: rerunning the check standards, remaking the check standards, recalibrating the Linear Plot, or carrying out maintenance on the instrument.

6.6.3.6 If both check standards pass the precision and accuracy requirements, the completed **GC/FID Calibration Check** worksheet will be added to the Quantitation Binder located next to the instrument. Document in the instrument logbook that the check standards Passed.

6.6.4 General

Solvent blanks will be injected prior to all other injections to verify that the column and syringe are free of contamination. The solvent blank will be run on the same method and immediately prior to the standard or sample runs.

Method parameters are available by the instrument or are electronically retrievable. The data and calculations for each linearity plot and for the check standard determinations will be maintained with the instrument.

6.7 Procedure

6.7.1 Sample Types

Cannabis products are of three principal types: herbal cannabis (flowers and leaves),

cannabis resin and liquid cannabis (oil). The typical ranges of total THC concentration found in different products are: 10-30 percent in flowers, 1-10 percent in leaves, 20-60 percent in resin products, up to 80 percent or more in oils.

6.7.2 Preparation of cannabis sample(s)

Flower or leaf samples are dried in an oven at leaves become brittle (water content <10%). The dried material is then pulverized and homogenized. If flowers are highly resinous, a mechanical grinder may be preferred.

6.7.3 Two hundred milligrams (200 mg) of dry homogenized herbal cannabis are extracted with 20mL of the internal standard (ITSD) solution (Tribenzylamine, 0.5mg TBA/mL EtOH) for 15 minutes in an ultra-sonic bath. (Note: approximately 100 mg of *cannabis resin* is required for extraction, and 50 mg of *liquid cannabis,* since they posses higher concentrations of cannabinoids.)

6.7.4 Transfer a 500µL aliquot of the extracted cannabis sample into a 2mL auto-sampler vial without the lid. Place in the heating block, in the fume hood, or GC for 12 minutes wherein the solvent is evaporated and the THCA and CBDA are decarboxylated.

6.7.5 Add 1.5mL of ethanol to form the final analyte solution and mix thoroughly. Tightly seal the lid onto the auto-sampler vial and place in the auto-sampler tray for analysis by GC/FID. Document the volume of sample and internal standard on the **GC/FID Cannabis Quantitation** worksheet.

6.7.6 Sample Analysis

Conditions for the capillary column method are:

Column	15 m x 0.25 mm, 0.25 µm
Phase	5% Diphenyl – 95% Dimethylpolysiloxane[1]
Carrier	Hydrogen, 1.1 mL/min 200-240° C
Injector	Split/Splitless, 280° C
Split ratio	20:1
Oven	2 min at 200° C, 10° C/min 200-240° C, 2 min at 240° C
Detector	FID 300° C, H_2 35 mL/min, Air 350 mL/min
Internal Standard	Tribenzylamine (TBA) in ethanol (0.5 mg/mL)
Injection	1.5 µL, Split
Elution Order	CBD, THC, CBN

6.7.6.1 Analyze the prepared sample using the GC/FID by running two replicate injections.

[1] AKGL has many different capillary columns that may be used in this analysis. The lab Director should be consulted with any questions regarding appropriate selection of columns.

Document the sample runs in the instrument logbook.

6.7.6.2 The concentration of each sample injection will be calculated using the linear regression equation from the linear plot.

6.7.6.3 The mean and % relative standard deviation (% RSD) of the concentrations will be calculated for the sample runs. The % RSD (the precision) must be equal to or less than 10% for the sample runs to be acceptable.

6.7.6.4 If the % RSD of the sample runs do not meet the listed criteria, then appropriate corrective action must be taken. This may include rerunning the sample or preparing a new sample extract.

6.7.6.5 If the sample runs pass the listed criteria, then the concentration of cannabis in the original sample is calculated using the mean of the sample extract runs, the volume of original sample used, and the volume of ISTD used. The concentration in mg/mL and in mg/100mL is noted on the **GC/FID Cannabis Quantitation** worksheet. This worksheet is to be included in the customer case file.

6.7.6.6 The chromatograms for each sample run, the internal standard run, and the corresponding solvent blank runs as well as the appropriate quantitation reports will be printed, labeled with the unique customer case identifier tag (METRC), customer case (LIMS) designators, date, and analyst's handwritten initials and will be maintained with the customer case file.

6.7.6.7 When quantitation of THCA and CBDA are required, the cannabis product sample must be derivatized, without the heat treatment which decarboxylates the cannabinoid, by first removing the EtOH (see 7.5.2.4) by blowing a stream of dry nitrogen across the samples surface. This takes ~ 15 minutes and should be performed in the fume hood. When the customer sample is dried in this fashion, the residue is dissolved in 1.5 mL of chloroform. 100 mL of N-methyl-N-trimethylsilyltrifluoroacetamide (MSTFA) is added to the cannabinoid/chloroform solution, covered, and subsequently heated at 70° C for 30 minutes. This solution is then subjected to the same GC analysis described above.

6.8 Interpretation

6.8.1 The linear plot calibration procedure makes use of the following equation to determine the concentration of cannabinoid present in a sample. The equation is:

$y = mx + b$ *where* y = *peak area of cannabinoid / peak area of ISTD*

m = slope of the line

x = concentration of cannabinoid / concentration of ISTD

b = Intercept

Solving this equation for the unknown concentration of cannabinoid yields

Concentration of cannabinoid = [y – b][ISTD concentration] / m*

The linear plot determines the values of m and b, the value of ISTD concentration is known and included in the method, and the value of *y* is determined from sample runs.

6.8.2 For each sample run, the instrument software will calculate and report the concentration of cannabinoid in mg/mL. This value will be used to determine the concentration of cannabinoid (mg/mL) in the original liquid sample using the following equation:

Concentration of cannabinoid = [conc cannabinoid in extract sample] [volume ISTD] (in original liquid sample) [volume original liquid sample used]

6.8.3 To report the concentration of cannabis per 100mL, multiply the previous value by 100.

6.9 Limitations

6.9.1 Two or more compounds, especially those with similar chemical structure, can have the same retention time under identical GC conditions.

6.9.2 If a co-eluting component masks the peak of interest, it can interfere with quantitation. It may be possible to resolve the problem by varying the GC program parameters.

6.9.3 The peak to be quantitated must be a single component peak that is well resolved.

6.10 Advantages

6.10.1 GC provides a good technique for separating components in a mixture and allows quantitation of complex mixtures.

6.10.2 Simple sample preparation is usually sufficient.

6.10.3 A GC auto-sampler increases the efficiency of analysis of numerous samples while functioning unattended.

6.10.4 Samples containing complex mixtures can be quantitated.

6.11 Literature and Supporting Documentation

6.11.1 D.A. Skoog and J.J. Leary, Principles of Instrumental Analysis, Saunders College Publishing, 1992, pp. 432,434, 622.

6.11.2 L.S. Ettre, Basic Relationships of Gas Chromatography, Perkin-Elmer Corporation, 1977.

6.11.3 "Gas Chromatography," Clarke's Analysis of Drugs and Poisons, 3rd edition, (London:

The Pharmaceutical Press, 2004) pp.425-499.

6.11.4 Recommended Methods for Identification and Analysis of Cannabis and Cannabis Products, United Nations Office on Drugs and Crime, (UNDOC) 2009, United Nations, NY.

6.12 Related Documents

6.12.1 GC/FID Quantitation Binder

6.12.2 GC/FID Internal Standard Preparation (AKGL-FIDISP)

6.12.3 GC/FID Calibration Standards Preparation (AKGL-FIDCSP)

6.12.4 GC/FID Linear Plot Calibration (AKGL-FIDLPC)

6.12.5 GC/FID Check Standards Preparation (AKGL-FIDCHSP)

6.12.6 GC/FID Calibration Check (AKGL-FIDCC)

6.12.7 GC/FID Cannabis Quantitation (AKGL-FIDDQ)

7. HEADSPACE GAS CHROMATOGRAPHY/FID (HS/GC/FID) FOR RESIDUAL SOLVENT ANALYSIS

7.1 Objective

An instrumental analytical technique for the characterization and quantification of residual solvents in cannabis concentrate products.

7.2 Safety

7.2.1 Use appropriate safety equipment when handling solvents, gases, and volatile chemicals. Refer to the AKGL Chemical Hygiene Manual and MSDS for additional safety information for specific chemicals.

7.2.2 Properly secure high-pressure gas cylinders

7.2.3 Use caution around hot surfaces such as oven interiors and injection and detector ports.

7.2.4 Discard all chemicals and any other pertinent materials in an appropriate manner.

7.3 Training

AKGL employees assigned to carry out HS/GC/FID analyses will be qualified to perform these analytical tests only after passing an internal AKGL training program that instructs on every aspect of the analytical methods described in this document. At the end of the training program the analyst must pass an actual analysis test with a "real-life" sample on the HS/GC/FID equipment before being certified. Internal certification will be supervised and approved by the Laboratory Director.

7.4 Equipment, Materials and Reagents

7.4.1 Gas Chromatograph/FID analytical instrument (8610C Gas Chromatograph from SRI Instruments).

7.4.2 Auto-sampler vials (voa) and caps

7.4.3 Microliter syringe

7.4.4 Residual Solvent analyses: 3ft HayeSep D packed column, ID= 1/8in (or other suitable column).

7.4.5 C1 C6 Standard Gas Mixture

7.4.6 BTEX Standard Gas Mixture

7.5 Standards, Controls and Calibrations

7.5.1 Methods have been developed using appropriate temperature programs and other critical parameters to ensure that the expected analytes will elute during data collection. The

methods should allow a reasonable time for unknown or unexpected analytes to elute.

7.5.2 Lists of methods with standard retention times and method parameters are available by HS/GC/FID instrument or are electronically retrievable. The lists provide guidance for the selection of the appropriate method for the compound(s) being analyzed. These lists will be updated once a year or more frequently as needed (for example following column changes or method).

7.5.3 Carrier gas (He) flow rate is adjusted to 15 mL/m at 7 psi.

7.5.4 The recommended temperature program (°C) for residual solvent testing is given in the following table; however, these temperatures may be modified to maximize peak separations or improve efficiency.

Initial Temperature (°C)	Hold Time (min)	Ramp (°C/min)	Final Temperature
100°	0.00	20.0°	180°
180°	0.00	5.0°	200°
200°	4.00	0.00°	200°

7.5.5 Calibration of the GC-FID is accomplished by tuning the instrument and run parameters to ensure that the sample's eluting peaks are assigned correctly based upon the retention times of known calibration standards.

7.5.6 In order to identify and quantify residual solvents in cannabis samples, a known gas standard is used to calibrate the response of the GC and detectors. For this purpose use Standard Gas mixes: a) methane, ethane, propane, butane, pentane and hexane (C1 - C6); and b) benzene, toluene, ethylbenzene and xylenes (BTEX) are used.

- Use the C1- C6 gas standard at 0.1% concentration (1000 ppm).
- Pressurize the gas cylinder by turning the release valve slightly counterclockwise.
- Close the valve by turning it clockwise.
- Pierce the septum with a 3 mL gas syringe and withdraw 1 mL of gas. (Note that there might be ~200 psi pressure behind the septum.)
- Remove the syringe from the gas sample bottle.
- Without puncturing the septum on the GC, position the syringe so that the needle is in the first part of the injection port
- Press the Start/Run button on the GC.
- Insert the needle through the septum as far as it will go, depress the plunger, and then remove the syringe.
- After injecting the C1-C6 standard to the column, six standard peaks elute: ethane, methane, propane, butane, pentane, and hexane, eluting in that order.
- Identify the peaks by their residence time and order of elution, label them and define

a retention window that spans each peak.

- Name the peaks and set integration parameters in the computer program.
- Input the known concentrations to the Peak Simple calibration screen for each retention window and select "Accept new calibration".
- Save the calibration for each peak to a .cal file.
- After all the peaks have been calibrated and saved, save all calibrations to a Component. This file can now be used to identify and quantify
- The FID has linear response to varying concentrations of carbon atoms. However, if a multi-point calibration is desired, the above steps can be repeated with different concentrations of C1-C6.

7.5.6 The procedure above is repeated with a BTEX standard gas mixture to calibrate for benzene, toluene, ethylbenzene and xylenes.

7.5.7 Solvent blanks are simply air samples that will be injected between case samples to verify that the analyte sample, column and syringe are free of contamination. The blank will be run on the same method as the sample and immediately before it.

7.5.8 Any significant peaks in the blank chromatograms should be properly investigated to identify their source (e.g. column breakdown, carryover from previous sample run, or instrumental contamination) so that appropriate action (such as performing instrument maintenance) can be taken as necessary. Any affected case samples and associated blanks should be rerun (this is not necessary in the case of minor peaks identified as column breakdown).

7.6 Procedure

7.6.1 Sample Preparation and Analysis

To prepare samples for residual solvent testing, you will need: 40mL voa vials, 1 per sample, and 100 milligrams (0.100 grams) of analyte per sample.

- Remove the cap from the 40mL voa vial, place the uncapped vial on the balance, and tare the reading (zero the reading).
- Using a balance that will measure .001 mg, weigh out approximately 100 milligrams of the analyte (extract, hash, waxes, butter, etc.). Place analyte into the vial and record the exact reading. (The reading on the balance does not have to be exactly 100 mg. The actual weight will be input to the Integration module.)
- Put the cap back on the vial.
- Place the vial into the sample heater, set at 70° C, and let sit for at least 30 minutes.
- The sample is now ready for a headspace analysis.
- Keep the cap on the 40mL vial sealed while it is in the sample heater.
- Use a 3mL gas syringe to puncture the septum of the vial, and pull 1mL of gas from the headspace of the vial. If re-using a syringe that was used for a previous GC run, flush the syringe with room air or purge gas to prevent carry over.

- Prepare to inject the analyte by positioning the syringe so that the needle is in the first part of the solvent injection port, without puncturing the septum,
- Press the Start/Run button on the GC.
- Insert the needle through the septum as far as it will go, depress the plunger and remove the syringe.
- After the end of the run, load the Component file containing calibrations for the elutes of interest.
- Shift and resize the retention windows as necessary to encompass the peaks.
- Open the Integration module and input the actual weight of the analyte.
- Select the Results window to display concentrations of the elutes.
- Each page printed will be labeled with the METRCS, the unique case identifier (LIMS) and analyst's handwritten initials and will be maintained with the case file. Chromatograms or notes should have the item METRCS designators, LIMS number, date, and method of sample preparation.

7.7 Interpretation

The linear plot calibration produces an equation, which can be used to determine the concentration of residual solvent present in a sample. The equation is

$$y = mx + b$$

where

y = peak area of solvent / peak area of ISTD
m = slope of the line
x = concentration of solvent / concentration of ISTD
b = Intercept

Solving the equation for the unknown concentration of solvent yields

Concentration of solvent = [y – b] [ISTD concentration] / m

The linear plot determines the values of m and b, the value of ISTD concentration is known and included in the method, and the value of y is determined from the sample runs.

7.7.1 For each sample run, the instrument will calculate and report the concentration of residual solvent in mg/mL. This value will be used to determine the concentration of residual (mg/mL) in the original gas sample using the following equation:

Concentration of solvent = [conc gas in extract sample] [volume ISTD] / [mass of original sample used]

7.8 Limitations

Real world cannabis samples will contain some concentration of organic decomposition products (plant matter gives off trace amounts of ethane, methane and other gases as they slowly decay).

7.9 Advantages

7.9.1 The technique is useful for analyzing small sample amounts that may be difficult to identify using other techniques.

7.9.2 A GC/FID auto-sampler increases the efficiency of analysis of numerous samples by functioning unattended.

7.10 Literature and Supporting Documentation

Douglas A. Skoog, *Principles of Instrumental Analysis*, 3rd Edition, (New York: Saunders College Publishing, 1985) 523-535; 554.

7.11 Related Documents

7.11.1 HS/GC/FID Quantitation Binder

7.11.2 HS/GC/FID Internal Standard Preparation (AKGL-HSFIDISP)

7.11.3 HS/GC/FID Calibration Standards Preparation (AKGL-HSFIDCSP)

7.11.4 HS/GC/FID Linear Plot Calibration (AKGL-HSFIDLPC)

7.11.5 HS/GC/FID Check Standards Preparation (AKGL-HSFIDCHSP)

7.11.6 HS/GC/FID Calibration Check (AKGL-HSFIDCC)

7.11.7 HS/GC/FID Residual Solvent Quantitation (AKGL-HSFIDDRSQ)

7.11.8 Maintenance Logbook

8. GAS CHROMATOGRAPHY/MASS SPECTROMETRY (GC/MS)

8.1 Objective

Present an instrumental analytical technique for the characterization and structural identification of cannabis products.

8.2 Safety

8.2.1 Use appropriate safety equipment when handling solvents, acids/bases, and volatile chemicals. Refer to the MSDS for additional safety information for specific chemicals.

8.2.2 Properly secure high-pressure gas cylinders

8.2.3 Use caution around hot surfaces such as oven interiors and injection and detector ports.

8.2.4 Discard all chemicals and any other pertinent materials in an appropriate manner.

8.3 Training

8.3.1 Each AKGL employee assigned to GC/MS analyses will be qualified to perform these analytical tests only after passing an internal AKGL training program that instructs on every aspect of the analytical methods described in this document. At the end of the training program the analyst must pass an actual analysis test with a "real-life" sample on the GC/MS equipment before being certified. Internal certification must be supervised and approved by the Laboratory Director.

8.4 Equipment, Materials and Reagents

8.4.1 Gas chromatograph/mass spectrometer analytical instrument

8.4.2 Auto-sampler vials and caps

8.4.3 Solvent(s) appropriate for the substance being analyzed as well as acids/bases used for extractions

8.4.4 Microliter syringe (where applicable)

8.5 Standards, Controls and Calibrations

Calibration of the mass spectrometer is accomplished by tuning the instrument to ensure that the mass-to-charge ratios (m/z) are assigned correctly and to provide leak detection.

8.5.1 The instrument will be tuned weekly when in use according to the manufacturer's specifications and may be tuned more frequently as deemed necessary.

8.5.2 Printed copies of tune records are maintained in the section. If the tune is not successful, the instrument will be taken out of service until instrument maintenance is performed and the problem recorded in the Maintenance Logbook

8.5.3 A standard check mix will be injected daily to verify instrument performance when in use. The standard printout will be maintained with the appropriate tune report. If the standard run does not provide acceptable mass spectral identifications, the instrument should be retuned and the standard mix rerun. If the standard still does not provide acceptable mass spectral identifications, then the instrument will be taken out of service until instrument maintenance is performed and the problem recorded in the Maintenance Logbook.

8.5.4 Solvent blanks prepared from the same solvent used to prepare samples will be injected between case samples to verify that the solvent, column and syringe are free of contamination. The solvent blank will be run on the same method as the sample and immediately before it.

8.5.5 A procedure blank will be run for samples that will be completely consumed by analysis to verify that the column, acids/bases used for extractions, solvents, and laboratory glassware used are clean prior to the analysis of case samples. A procedure blank for GC/MS analysis should be prepared in exactly the same manner as the sample including the use of the same non-disposable glassware and solvents. The procedure blank is to be run on the GC/MS immediately prior to and using the same method as the sample run. Documentation of procedure blanks should be included in the case notes.

8.5.6 Any significant peaks in the blank chromatograms should be properly investigated to identify their source (e.g. column breakdown, carryover from previous sample run, or instrumental contamination) so that appropriate action (such as replacing solvents or performing instrument maintenance) can be taken as necessary. Any affected case samples and associated blanks should be rerun (this is not necessary in the case of minor peaks identified as column breakdown).

8.5.7 For less frequently encountered substances, standards should be run within the same timeframe that the sample is tested, and a copy of the standard run should be retained in the customer case file. Examples of less frequently encountered substances include pesticides, monoterpenes, or sesquiterpenes. An acceptable timeframe for running the samples and standards would be within the same month as long as instrument conditions have not changed (column replacement or method modifications). Available and verified standards are a requirement for this practice.

8.6 Procedure

8.6.1 GC/MS Operating methods were developed using appropriate temperature programs and other critical parameters to ensure that the expected substance(s) will elute during data collection. The methods should allow a reasonable time for unknown or unexpected compounds to elute.

8.6.1.2 Lists of methods with standard retention times and method parameters are available by the GC/MS instrument or are electronically retrievable. The lists provide guidance for the selection of the appropriate method for the compound(s) being analyzed. These lists will be updated once a year or more frequently as needed (for example following column changes or method modifications).

8.6.2 Sample Preparation and Analysis

Extract samples into a suitable solvent and inject into the instrument following the procedure described in Section 6. Evaluate and print the results of the GC/MS analyses for product samples and corresponding blank runs, and include the following in the case file:

8.6.2.1 The complete Total Ion Chromatogram (TIC) for each sample and corresponding blank run. Evaluated peaks on the TIC will be labeled with the identification of the corresponding mass spectra or NAM. Analyst discretion will be used when selecting peaks for evaluation based on analytical scheme and circumstances of the customer's case.

8.6.2.2 Mass spectra for all evaluated peaks on the TIC.

8.6.2.3 Mass spectra for identified peaks will include documentation of the comparison of the unknown mass spectra to a known standard, either a stored library comparison or a literature source. If a literature source is used for comparison, the source will be cited in the case file.

8.6.2.4 Mass spectra for peaks with no known reference comparison (labeled on the TIC as NAM) will be printed and also labeled as NAM. The printout may be done manually or as part of a method's automatic data analysis.

8.6.2.5 Peaks from the TIC that are not evaluated will not have printed mass spectra.

8.6.2.6 If a background subtraction is performed for a peak mass spectrum, then retain a copy of the original mass spectrum with the case file as well as the background subtracted mass spectrum. Note the retention time used to generate the background subtracted spectrum on the printout.

8.6.2.7 Each page printed will be labeled with the METRC identifier, the AKGL LIMS identifier

and the examiner's handwritten initials, and will be maintained with the case file. Spectra or notes should have the item designators, date, and method of sample preparation (if not listed on the Cannabis Product Examination Sheet).

8.7 Interpretation

8.7.1 Library searches can be used to provide useful information pertaining to the identity of a compound but should not be used as a replacement for analyst verification of mass spectral fragmentation patterns when making an identification.

8.7.2 If used for comparison, results from library searches must be printed and retained with the sample spectra.

8.8 Limitations

8.8.1 Some compounds may not be suitable for GC/MS analysis due to a variety of factors; for example, high injection port temperatures cause some compounds to break down or rearrange before they are ionized, preventing their identification, i.e., THCA and CBDA.

8.8.2 It may be difficult to identify individual compounds in a homologous series (straight chain hydrocarbons, fatty acids).

8.9 Advantages

8.9.1 Generally, mass spectra of compounds of interest are specific to single compounds and may be used for positive structural identification.

8.9.2 It may be possible to separate and identify complex mixtures that are difficult to separate through ordinary procedures.

8.9.3 The technique is useful for analyzing small sample amounts that may be difficult to identify using other techniques.

8.9.4 A GC/MS auto-sampler increases the efficiency of analysis of numerous samples by functioning unattended.

8.10 Literature and Supporting Documentation

8.10.1 Douglas A. Skoog, *Principles of Instrumental Analysis*, 3rd Edition, (New York: Saunders College Publishing, 1985) 523-535, 554.

8.10.2 F. W. McLafferty, *Interpretation of Mass Spectra*, 4th Edition, (Sausalito, California: University Science Books, 1993).

8.10.3 Jehuda Yinon, *Forensic Mass Spectrometry*, (Boca Raton, Florida: CRC Press, Inc., 1987).

8.10.4 J. Throck Watson, *Introduction to Mass Spectroscopy: Biomedical, Environmental, and Forensic Applications*, (New York: Raven Press Books, 1140 Avenue of the Americas, 1976).

8.10.5 R. E. Ardrey, "Mass Spectrometry" in *Clarke's Isolation and Identification of Drugs*, (London: The Pharmaceutical Press, 1986), 251-263.

8.11 Related Documents

8.11.1 GC/MS Quantitation Binder

8.11.2 GC/MS Internal Standard Preparation (AKGL-MSISP)

8.11.3 GC/MS Calibration Standards Preparation (AKGL-MSCSP)

8.11.4 GC/MS Linear Plot Calibration (AKGL-MSLPC)

8.11.5 GC/MS Check Standards Preparation (AKGL-MSCHSP)

8.11.6 GC/MS Calibration Check (AKGL-MSCC)

8.11.7 GC/MS Quantitation (AKGL-MSQ)

8.11.8 GC/MS Maintenance Logbook

9. REAGENT QUALITY ASSURANCE GUIDELINES

9.1 Objective

The following describes quality assurance guidelines for reagents and chemical preparations used in the analysis procedures described in this document.

9.2 Safety

Appropriate safety equipment should be used when preparing reagents and handling volatile chemicals. Refer to the MSDS for additional safety information for specific chemicals. Recommended procedures for a safe working environment and additional information on working safely in the laboratory and can be found in the AKGL Chemical Hygiene Plan.

9.3 Practice

9.3.1 Labeling

All pertinent reagents and solutions will be labeled with the identity of the reagent and the date of preparation (or lot number).

A Reagent Logbook will be maintained and will include the following information, when applicable:

- Reagent preparation date
- Preparer's initials
- Standard used and the results of a positive quality control check of the reagent
- Results of a negative (blank) quality control check of the reagent
- Initials of the analyst(s) who quality tested the reagent and the date of testing

9.4 Quality Testing for Frequently Used Reagents

Frequently used reagents will be quality tested at the time of preparation and monthly thereafter. Upon preparation, the preparer will record his or her initials in the logbook along with the date prepared. This same date will also be reflected on the stock reagent container. When the reagent is quality tested the appropriate information is recorded in the logbook. The quality testing will include both a positive control using an appropriate standard and a negative (blank) control. In addition to the date of preparation, the date of the most recent quality test will be noted on the stock reagent bottle.

9.4.1 All general use containers (aliquots) of frequently used reagents will be quality tested monthly along with the stock reagent and the results recorded in the logbook. These containers will be labeled with the date of reagent preparation and the date of the most

recent quality test. When a new stock reagent is prepared, the general use containers will be replaced with this reagent after it has been quality checked.

9.4.2 Aliquots for reagents used at an analyst's work area will be replaced each month from the stock reagent bottle after it has been quality checked. These containers will be labeled with the date of reagent preparation and the date of the most recent quality test. It is the analyst's responsibility to document replacement of his/her aliquots.

9.5 Quality Testing for Infrequently Used Reagents

Infrequently used reagents will be quality tested upon preparation and the results as well as the preparer's initials and the date of preparation will be recorded in the logbook. Subsequent quality testing will be performed by the analyst prior to use and these results as well as the standard used will be documented in the case note

9.6 Quality Assurance

9.6.1 No reagent or other chemical preparation will be used in customer casework if it is not working properly or if it is contaminated.

9.6.2 If an analyst has reason to suspect that a reagent or other chemical preparation is not working properly or is contaminated, he or she must:

- Stop customer casework with these reagents until the problem is corrected.
- Check the reagent or system with standards or proper sample controls.
- Discard the reagent if it fails the quality check, prepare a new reagent, and quality check the new reagent with a known standard.
- Identify casework that may have been affected by the reagents/chemicals that failed the quality check and re-test with quality checked reagents.
- Inform the Laboratory Director if the problem persists.

9.7 Related Documents

9.7.1 Reagent Logbook

9.7.2 Monthly Quality Check for Frequently Used Stock Reagents (AKGL- QCMFRSTOCK)

9.7.3 Monthly Quality Check for Generally Frequently Used Reagent Aliquots (AKGL-QCMFRGEN)

9.7.4 Quality Check for Infrequently Used Stock Reagents (AKGL-QCINFRSTOCK)

9.7.5 Quality Check for Stock Acids and Bases (AKGL-QCACIDBASE)

10. ANALYSIS TERMINOLOGY

Validation. Validation is defined as: "Establishing documented evidence which provides a high degree of assurance that a specific process will consistently produce a product meeting its pre-determined specifications and quality attributes". The validation procedure documents that the method is fitted for its purpose. The properties of the method are revealed by determining the following validation parameters: LOD, LLOQ, ULOQ, Linearity, Specificity, Precision, Accuracy, Range, and Robustness

Lower limit of detection (LOD). LOD is the lowest concentration where an analyte can be detected. It can be calculated by dividing the area of the signal on the area of the noise, and this ratio (signal to noise ratio, S/N) should be ≥ 3. The signal of the noise is the height of the baseline.

Lowest limit of quantification (LLOQ). LLOQ is the lowest concentration where an analyte can be quantified. It can be calculated in the same way as LOD, but the S/N should be ≥ 10. If the signal to noise ratio is low, it is difficult to say how much of the signal that is due to the analyte, and how much that is due to the matrix, thus a reliable quantification would be difficult.

Upper limit of quantification (ULOQ). ULOQ, upper limit of quantification, is the highest concentration where the analyte can be quantified, before having a saturated signal. At this point, the calibration curve will go from being linear to parabolic.

Linearity. Linearity is the ability of the method to give a linear calibration curve in a given concentration range. The ratio is given by the response of the analyte, which is divided by the response of the internal standard, and allows a plot at different concentrations. A calibration curve is then obtained, and allows the calculation of an analyte in an unknown sample. The linearity of the equation is described by R, the regression coefficient. R2 should be as close to 1 as possible, but a value above 0.99 is satisfactory.

Specificity. The specificity is the ability of the method to detect and quantify the analyte in presence of contaminations in the sample. The signal of the analyte should not be interfered by these. The specificity of the method can be tested by analyzing negative samples from 6 different subjects, and 3 samples per subject are analyzed.

Range. This is the interval between the lower and the upper concentration where the method can quantify the analyte with a suitable accuracy, precision and linearity.

Precision. This parameter describes the repeatability of the results, and are expressed by a relative standard-deviation (RSD), which is the standard deviation of the results divided by the mean value of the same results, and multiplied by 100. A low RSD indicates a good precision. 6 samples for 3 concentrations in the range are analyzed. The analyzed concentrations should reflect the concentration range.

Accuracy. Accuracy represents the closeness between the theoretical value and the calculated value. Hence, this parameter considers the uncertainty and the precision of the method. The uncertainty can be determined by calculation of the theoretical values in the sample by using a calibration curve. The calculated- and the theoretical value are plotted in a curve. The linearity and the slope of the curve demonstrate the correlation between these values; a linear curve with a slope of 1 suggests a good correlation between these.

Robustness. The robustness is an assessment on the ability of a method to stay unaffected by minor changes in the procedure, i.e., small variations in pH. This is to make sure that the analysis is not affected by variations that might occur in a sample preparation.

11. ABBREVIATIONS

~	Approximately
AB	Analytical Balance
A/B extr	Acid/Base extraction
ACLS	Amera-Chem Library Search
AKGL	AK Green Labs LLC
AR	Administrative Review
BB	Bulky Balance
bot(s)	Bottle(s)
CBD	Cannabidiol
CBDA	Cannabidiol Acid
CBN	Cannabinol
CRM	Certified Reference Material
CT	Cannabis Trim
CF	Cannabis Flower
ECN	Effective Carbon Number
Extr	Extracted or Extraction
FID	Flame Ionization Detector
g	Gram(s)
GC	Gas chromatograph
gr	Gross
HPLC	High Performance Liquid Chromatography
ISTD	Internal Standard
Kg	Kilograms
lb	Pounds
L	Liters
LC	Liquid chromatography
liq	Liquid
LIMS	Laboratory Information Management System
LOD	Lower Limit of detection
LOQ	Lower Limit of quantification
LLOQ	Lowest Limit of Quantification
mari/marij	Marijuana

mg	Milligrams
ml	Milliliters
MT	Mettler Toledo top-loading balance
MCB	Marijuana Control Board
NAM	No Acceptable Match
MSTFA	N-methyl-N-trimethylsilyltrifluoroacetamide
NAP	No Analysis Performed
NVS	No Visible Sample
Neg	Negative
oz/ozs	Ounces
PDMS	Polydimethylsiloxane
pl(s)	Plastic(s)
PS	Plant Substance
QC	Quality control sample
Rf	Retention factor (TLC)
RT	Retention time
Sub	Substance
Std	Standard
Syncann	Synthetic-cannabinoid
TB	Top-Loading Balance
TR	Technical review
THC	Δ9-tetrahydrocannabinol
THCA	Δ9-tetrahydrocannabinolcarboxylic acid
TIC	Total Ion Chromatograph
TP	Temperature program
ULOQ	Upper limit of quantification
UV/VIS	Ultraviolet/Visible (Spectrophotometry)
UV(PDA)	Ultraviolet Photo Diode Array Detector
Wt	Weight
zip(s)	Ziploc(k)(s)

(this is not intended to be an exhaustive list as many substances have commonly accepted or otherwise documented abbreviations)

12. REFERENCES

References used for analyte identification will be documented in the customer case file. The following is a list of commonly used pharmaceutical references (other sources may be used as long as they are properly documented in the case file):

- Physicians Desk Reference (PDR)
- Amera-Chem Logo Search (ACLS) DEA Logo Search (DEA)
- Poison Control
- Drug Identification Bible (DIB) Drugs.com (http:\\www.drugs.com)
- Pharmaceutical identification from packaging or manufacturer information

When analyzing compounds, particularly cannabis products, using GC/MS, the spectra will be compared to a standard from a reference source. The source of the standard spectrum will be documented in the customer case file. The following is a list of common reference sources for standard GC/MS spectra (other sources may be used as long as they are properly documented in the case file):

- NIST mass spectral library (various editions) SWGDRUG mass spectral library
- American Academy of Forensic Sciences (AAFS) mass spectral library In-
- Clarke's Isolation and Identification of Drugs (various editions) Mills Instrumental Data for Drug Analysis (various editions) CND Analytical series
- Microgram Journal / Bulletin Journal of Forensic Science
- Forensic Toxicology

Commercial libraries of mass spectra and infrared spectra in electronic form that were acquired from external sources for use with the section's analytical instrumentation meet these requirements, as do published reference collections and reputable scientific papers.

End of Document

Chemical Hygiene Plan

AK Green Labs LLC

Updated April, 2016

Table of Contents

1. Introduction

1.1 Scope

This manual applies to all employees who work for AK Green Labs (AKGL). It must be read by all employees, and acknowledged, before they begin work in order to familiarize them with the safety and health policies and to inform them of their rights and obligations under federal and state regulations.

This chemical hygiene plan applies to all laboratories of AKGL. The safe storage, use and disposal of chemicals at AKGL require policies for the protection of all employees and the environment. Chemicals, whether simple reagent-grade materials or commercial products and their associated wastes, are the focus of increased regulatory actions by local, state and federal governments.

This manual is to provide the user of chemicals in the laboratory with basic safety information regarding the use of these chemicals and the safe disposal of waste. This manual is not intended be an encyclopedia of all chemicals and hazards that one may encounter in their analyses or research in the laboratory.

1.2 Rights and Responsibilities

AKGL is required by law to advise all employees of their rights and responsibilities regarding the Hazard Communication Standard, Personal Protective Equipment Standard and Occupational Exposure to Chemicals in the laboratory. In addition, the standard Occupational Safety and Health Administration (OSHA) "Notice to Employees" poster has been placed on the notice board in the coffee area.

AKGL is responsible for:

1. Developing occupational safety and health programs
2. Monitoring the workplace for hazards and notifying workers of exposures
3. Keeping records of all monitoring data and health hazards
4. Assessing and correcting safety and health hazards
5. Providing personal protective equipment and other means to reduce exposure to hazardous agents
6. Maintaining good air quality, ventilation, and temperature
7. Providing safe chemical storage
8. Writing standard operating and work procedures
9. Establishing emergency procedures
10. Providing relevant training

Employees have the right to:

- Observe the monitoring of hazardous materials and harmful physical agents in your workplace
- See the records of workplace monitoring
- Receive prompt notification if you have been exposed to hazardous materials or harmful physical agents in excess of permissible limits
- See their personal records of exposure to workplace hazards
- Read occupational safety and health standards and regulations

Employees are personally responsible for:

- Observing all safety and health standards and regulations that apply to your work
- Following established standard operating and work procedures
- Reporting hazardous conditions promptly and warning coworkers about health hazards
- Responding to warning signals that may be activated in the event of fire or other emergencies
- Reporting emergencies and knowing emergency procedures
- Attending health and safety training
- Asking your supervisor if you have questions about occupational safety or health

AKGL requires that all those working in the lab are familiar with the Materials Safety Data Sheets (MSDSs) for the substances they will be using. MSDSs are kept in a in a highly visible box mounted next to the Falmmabes storage cabinet.

AKGL requires the use of proper safety clothing and equipment. Where appropriate, this includes safety glasses, goggles, face shields, lab coats, aprons, and gloves. When appropriate, this also means doing procedures in the hood. All employees must receive safety training before working in the lab.

All those working in the lab are required to know the standard operating procedures applicable to their tasks; these are filed in the same location as the MSDSs. Several other materials are also kept at AKGL:

1. Hazard assessments for all work areas (which are in the AKGL Safety Inspections notebook, near the MSDS's)
2. Lists of toxic and carcinogenic chemicals (kept in the AKGL General Safety Information notebook, near the MSDS's)
3. Emergency Action Plans (included in this manual)
4. Information on hazardous waste disposal ("Hazardous Laboratory Chemicals Disposal Guide," near the MSDS's, also see safetty officer for specific AKGL policies)

AKGL does not permit food or drink in the lab. Smoking in the lab is strictly forbidden. No sandals or open-toed shoes may be worn in the lab, ever.

Children are not permitted in the lab.

In an emergency, the following people can be contacted at home:

Brian Coyle	303 304-9661 (cell)
Tim Hinterberger	907 317-62509 (cell)
TBD	XXX-XXXX

I have read and understand this information.

Employee name	Signature	Date

2. Introduction to Industrial Hygiene

Several agencies have established regulations, standards, and guidelines for industrial hygiene and safety:

- OSHA Occupational Safety and Health Administration (issues mandatory regulations that have the power of law)
- ANSI American National Standards Institute
- NIOSH National Institute for Occupational Safety and Health
- ACGIH American Conference of Governmental Industrial Hygienists
- DOE Department of Energy (combines regulations and guidelines from the agencies above into one industrial hygiene program)

2.1 Industrial Hygiene

There are four main types of industrial hygiene hazards to which you could be exposed at work:

- Chemical hazards – liquids, solids, fibers, mist and dust, fumes and smoke, gases and vapors
- Ergonomic factors – video display terminals and repetitive motion
- Electrical hazards – high voltages
- Mechanical hazards – moving parts and machining instruments

The four principles of industrial hygiene are:

- Anticipation – identify and control hazards before an operation begins or a facility is constructed
- Recognition – identify hazards and their effects
- Evaluation – analyze hazards and their effects by using the senses (smelling, seeing, hearing, noticing body signs and symptoms) and monitoring instruments (more accurate but not available for all hazards)
- Control – implement specific requirements to eliminate or minimize hazards and their effects

The degree or extent of any health hazard depends on the conditions of exposure to the hazard:

- routes of entry into the body
- concentration or level
- exposure time
- individual susceptibility

Hazards in the workplace can be controlled by a variety of methods. These are, from the most to the least preferred: elimination, substitution, engineering controls, administrative controls, and personal protective equipment (PPE).

Engineering controls include ventilation systems, remote handling, glove boxes, and fume hoods. Administrative controls include proper work practices, limits in exposure time, training, standard operating procedures, and special work permits.

PPE should only be used to supplement other methods and includes protective clothing (lab coats, coveralls, and gloves), protective eye wear (safety glasses, goggles, and face shields), and respiratory equipment.

2.2 Industrial Safety

A safety hazard is any condition that could lead to an accident or injury. Hazards can involve:

1. Physical conditions (such as wet, slippery floors)
2. Location of work near hazardous equipment
3. Improperly maintained machinery and tools

4. Processes like welding and machining

Unsafe work practices can create hazardous conditions. Examples are using heavy equipment without authorization or training, and using power tools with frayed wires.

Workplace accidents can result from:

- getting struck by or against an object
- getting caught in or under equipment
- contact by a harmful substance such as a spray of acid
- contact with an energized electrical wire
- slips, trips and falls
- overexertion

Planning is one of the primary tools to ensure safe operation. Workers at AKGL should prepare standard operating procedures for activities to be conducted routinely and obtain special work permits for operations involving particularly hazardous materials.

I have read and understand this information.

Employee name	Signature	Date

3. Hazardous Chemicals

3.1 Definition

Hazardous chemicals are chemical for which there is statistically significant evidence that acute or chronic health effects may occur in exposed employees. In this definition, the term chemical includes dusts, mixtures, and common materials such as paints, fuels, and solvents.

In most cases, the label on the container will indicate if the contents are hazardous. Look for key words like caution, toxic, dangerous, corrosive, irritant or carcinogenic.

3.2 Types of Hazards

Irritants are materials that cause inflammation of the body surface with which they come in contact. The inflammation results from concentrations far below those needed to cause corrosion.

Common irritants include substances such as:

- ammonia
- alkaline dusts and mists
- hydrogen chloride
- hydrogen fluoride
- halogens
- ozone
- phosgene
- nitrogen dioxide

Irritants can also cause changes in the mechanics of respiration and lung function. These include:

- acetic acid
- formaldehyde
- formic acid
- sulfuric acid
- halogens

Long term exposure to irritants can result in increased mucous secretions and chronic bronchitis.

A *primary irritant* exerts no systemic toxic action, either because the products formed on the tissue of the respiratory tract are non-toxic or because the irritant action is more severe than any systemic toxic action. Example: hydrogen chloride.

A *secondary irritant's* effect on mucous membranes is overshadowed by a systemic effect resulting from absorption. These include: hydrogen sulfide and aromatic hydrocarbons. Exposure to a secondary irritant can result in pulmonary edema, hemorrhage and tissue necrosis.

Simple Asphyxiants deprive the tissue of oxygen. Simple asphyxiants are inert gases that displace oxygen. Examples include: nitrogen, carbon dioxide and helium

Primary anesthetics have a depressant effect upon the central nervous system, particularly the brain. Examples include: halogenated hydrocarbons and alcohols.

Some toxic agents act on the blood or hematopoietic system. The blood cells can be directly affected or the bone marrow can be damaged. Examples of these include:

- nitrites
- aniline
- toluidine
- nitrobenzene
- benzene

The term carcinogen describes any agent that can initiate or speed the development of malignant or potentially malignant tumors, malignant neoplastic proliferation of cells, or cells that possess such material. Carcinogens and probable carcinogens commonly used in large quantities include formaldehyde, benzene, ethylene amine, ethylene oxide, and chloroform. Some other common suspected carcinogens are furan, 1,4-dioxane, propylene oxide, dichloromethane, 1,2-dichloroethane, acrylamide, acrylonitrile, and trichloroethylene.

A carcinogen is any substance that meets one of the following criteria:

- It is regulated by OSHA as a carcinogen
- It is listed under the category, "known to be carcinogens" in the National Toxicology Program (NTP), "Annual Report of Carcinogens" (latest edition)
- It is listed under Group 2A or 2B by IARC or under the category "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals according to any of the following criteria:
  - After inhalation exposure to doses of less than 10 mg/m^3 for 6-7 hours per day, 5 days per week, for a significant portion of a lifetime,
  - After repeated (weekly) skin application of 300 mg/kg of body weight
  - After daily oral doses of less than 50 mg/kg of body weight.

Reproductive hazards are chemicals that affect the reproductive capabilities including chromosomal damage (*mutagens*) and effects on the fetus (*teratogens*).

A *mutagen* affects the chromosome chains of exposed cells. The effect is hereditary and becomes part of the genetic pool passed on to future generation.

A *teratogen* (embryotoxic or fetotoxic agent) is an agent that interferes with normal embryonic development without damage to the mother or lethal effect on the fetus. Effects are not hereditary.

4. Labels

Labels displayed on the container of a chemical serve to provide immediate warnings of all potential dangers (both health and physical). OSHA's Hazard Communication Standard has established minimum labeling requirements for chemical containers in the workplace. All chemical containers at AKGL shall be labeled by the person filling the container to meet these requirements. Containers should be labeled immediately before or after filling. The following information is required on **EVERY** container kept for more than one day:

- Contents of the container. Chemical formulas or structural formulas are not acceptable. If you do not know what the substance is, for example if it is a product of a chemical reaction, then mark with reference to a laboratory notebook.
- Name of analyst filling container
- Date of synthesis
- Physical and health hazards

Containers without this information will be **DISCARDED.** However portable containers intended for immediate use by the employee doing the transfer do not need to be labeled.

All containers that hold carcinogenic chemicals, reproductive hazards or acutely toxic chemicals must be properly labeled regarding the health hazard posed by the chemical. Most new chemical reagents will have the health hazard listed on the container, but it is essential that the employee read carefully the MSDS before using a chemical for the first time.

4.1 Sample Labels

1) For a known compound

John Doe
5/2/2016
buffered hydrofluoric acid (HF)

2) For an unknown substance

John Doe
5/2/2016
GZ1-15A

It is also essential that all employees understand the National Fire Protection Association (NFPA) Code and Personal Protetion Index.

I have read and understand this information.

Employee name _____ Signature _____ Date _____

5. Handling of Chemicals

5.1 General

Know the physical and health hazards associated with the chemicals you are using. Carefully read the chemical's label and material safety data sheet (MSDS) before using a chemical for the first time. Also review the appropriate Standard Operating Procedure. These documents will provide any special handling information that you may need. After the potential hazards associated with the chemicals and the experimental processes are evaluated you can modify work procedures so that laboratory hazards are minimized or eliminated.

Keep the following guidelines in mind when handling chemicals:

- Do not work alone in the laboratory. If you do need to work alone, notify someone.
- Use required personal protective equipment.
- Label all containers with chemical content.
- Wear nitrile gloves to prevent skin exposure
- Keep your hands and face clean. Wash thoroughly with soap and water after handling any chemical and whenever you leave the lab.
- Avoid direct contact with any chemical. Always wear a laboratory coat.
- Keep chemicals off your hands, face and clothing, including shoes.
- Never smell, inhale or taste a chemical.
- Smoking, drinking and eating is forbidden in areas where hazardous chemicals are used or stored.
- Always use chemicals with adequate ventilation or in a chemical fume hood. Refer to the MSDS and the standard operating procedure to determine what type of ventilation is needed.
- Use hazardous chemicals only as directed and for their intended purpose.
- Inspect equipment or apparatus for damage before adding a hazardous chemical. Do not use damaged equipment.

5.2 Laboratory Fume Hoods

Local exhaust ventilation is the one of the best engineering methods available to reduce the health hazard risk associated with the use of hazardous chemicals in the laboratory. Laboratory fume hoods are the most common local exhaust ventilation devices found in the laboratory. Fume hoods are used to prevent hazardous, offensive, or flammable gases and vapors from mixing with the general room air. A hood, especially with the sash down, acts as a physical barrier between the laboratory workers and chemical reactions. The hood can also contain accidental spills of chemicals.

Check the MSDS, appropriate Standard Operating Procedure, or chemical label for special ventilation requirements, such as:

- Use with adequate ventilation
- Use in a fume hood
- Avoid inhalation of vapors
- Provide local ventilation

Ventilation recommendations must be adapted to the work site and the specific process.

To be effective, laboratory fume hoods must be installed and used correctly. The National Research Council in Prudent Practices for Handling Hazardous Chemicals in Laboratories; (1981) recommends that the following factors be remembered in the daily use of hoods:

1. Hoods should be considered as backup safety devices that can contain and exhaust toxic, offensive, or flammable materials. Hoods should not be used as a means for disposing of

chemicals. Thus, apparatus used in hoods should be fitted with condensers, traps, or scrubbers to contain and collect waste solvents, toxic vapors and dust.

2. Hoods should be evaluated before use to ensure adequate face velocities (typically 60-100 feet/min) and the absence of excessive turbulence. Further, some continuous monitoring device for adequate hood performance should be present and should be checked before each hood is used. If inadequate hood performance is suspected, it should be established that the hood is performing adequately before it is used.
3. Except when adjustments of apparatus within the hood are being made, the hood should be kept closed: vertical sashes down and horizontal sashes closed. Sliding sashes should not be removed from horizontal sliding-sash hoods. Keeping the face opening of the hood small improves the overall performance of the hood.
4. The airflow pattern, and thus the performance of a hood, depends on such factors as placement of equipment in the hood, room drafts from open doors or windows, persons walking by, or even the presence of the user in front of the hood. For example, the placement of equipment in the hood can have a dramatic effect on its performance. Moving an apparatus 5-10 cm back from the front edge into the hood can reduce the vapor concentration at the user's face by 90%.
5. Hoods are not intended primarily for storage of chemicals. Materials stored in them should be kept to a minimum, Stored chemicals should not block vents or alter airflow patterns. Whenever practical, chemicals should be moved from hoods into cabinets for storage.
6. Solid objects and materials (such as paper) should not be permitted to enter the exhaust ducts of hoods as they can lodge in the ducts or fans and adversely affect their operation.

5.3 Personal Protective Equipment

Personal protective devices are to be used only where engineering and administrative controls cannot be used or made adequate, or while controls are being instituted. Engineering and administrative controls to reduce or eliminate exposures to hazardous chemicals include:

- substitution of a less hazardous substance
- substitution of less hazardous equipment or process (e.g., safety cans for glass bottles)
- isolation of the operator or the process
- local and general ventilation (use of fume hoods)
- use of secondary containment

5.3.1 Eye Protection

Eye and face protection must be worn whenever its use will reduce or eliminate injury. It is recommended that eye protection be worn in the laboratory whenever chemicals are in use.

Safety glasses with side shields do not provide adequate protection from splashes, therefore, when the potential for a splash hazard exists other eye protection and/or face protection must be worn. Splash goggles (acid goggles) with splash proof sides or a face shield must be used when protection from a chemical splash is needed.

Eye protection must be made available to employees and visitors when the potential for eye injury exists.

5.3.2 Lab Coats and Clothing

Lab workers must wear lab coats while in a lab where chemicals are being handled. *Lab coats should not be worn outside of the lab.* The employer (principal investigator) will provide lab coats at no cost to all employees who work in the lab. Long pants and closed-toe shoes should be worn under the lab coat. Shorts and sandals or open-toed shoes must not be worn in the lab.

5.3.3 Gloves

Disposable latex or nitrile gloves provide adequate protection against accidental hand contact with small quantities of most laboratory chemicals. These gloves provide a chemical-resistant barrier between the worker's hand and the reagent. Lab workers who contaminate their gloves should immediately remove them, wash their hands and don new gloves. **Gloves should not be worn outside of the lab.**

I have read and understand this information.

Employee name	Signature	Date

6. Ordering Chemicals

Appropriate safety planning should go into every experiment before starting the experiment. This includes planning what chemicals will be necessary, how much is needed, how the chemicals will be stored, and how the chemicals will be disposed. The best rule of practice for amounts of chemicals to order is that, if only a small quantity of chemical will be used, the less one orders, the better. For example, if a person needs to use 50 mL of hexanol in an experiment, he or she may find that this chemical is only sold in 100 mL or 500 mL quantities. If the person only needs 50 mL and does not expect anyone else in the lab to use this chemical within the following six months, this person should order the smaller quantity, even if significant "savings" can be obtained by ordering the larger quantity. These so-called "savings" may be lost by the need to store, maintain, or dispose of a little-used chemical.

Planning for disposal of chemicals is also important in planning an experiment. The following two pages contain a form that must be filled out by the person ordering and signed by the safety officer every time a chemical order is placed. Especially important is to consider storage times of a chemical and chemicals that require special disposal procedures. Please, always remember to initial and date the chemical bottle when it arrives!

Some chemicals, when stored a long time or under inappropriate storage conditions, can form harmful side-products. Among these chemicals are some ethers and amides which must only be stored for three months and other ethers which can be stored up to six months. If these chemicals are kept longer than the allotted storage time, they can form harmful or explosive by-products. Many of the ethers will form peroxides that can explode when the container is opened. A more extensive (although not comprehensive) list of chemicals that have storage concerns is given in the following two pages.

Also, some chemicals are regulated and difficult to dispose. A list of these chemicals (not comprehensive) is given in the following two pages. These chemicals usually cannot be disposed in the normal wastes containers. Thus, the safety officer must be notified and will make special provisions for disposal of these chemicals.

Determining the safety hazards and disposal difficulties for each chemical ordered is the responsibility of the person ordering the chemical. Some useful materials to make these determinations are 1) the "Hazardous Laboratory Chemicals Disposal Guide" in the lab by the

MSDS forms, 2) the website http://toxnet.nlm.nih.gov : use the HSDB database and look especially under chemical safety and handling, or 3) the chemical's MSDS, which is in the MSDS section in the lab and also on the web. For example, www.chemfinder.com is one site that contains MSDS's for chemicals.

6.1 Safety Considerations for Ordering Chemicals

Use the following as a guide when ordering new chemicals. The final sheet should be given to JOHN DOE for approval, or if JOHN DOE is not available, the person acting as Safety Officer in JOHN DOE's place.

Chemical: Date: Intended use: Quantity needed/duration:

1. _____
2. _____
3. _____
4. _____
5. _____

Example: ***isopropyl ether 5/20/02 extraction solvent 100mL/Three months***

Always check the hazards on each chemical ordered. As best you can, answer the following questions:

1. Does the chemical have any special hazards?
2. Is the chemical highly toxic?
3. Is the chemical carcinogenic?
4. Does the chemical have any special storage considerations or limits to storage times?

The following resources may be useful in answering the above questions:

- Hazardous Laboratory Chemicals Disposal Guide, located near the MSDS's in the laboratory;
- Website http://toxnet.nlm.nih.gov. Use the HSDB database and look especially under chemical safety and handling, or;
- MSDS for he chemical. You can also find the MSDS on the web: www.chemfinder.com or www.sigma-aldrich.com.

Update the inventory after you receive a new chemical, and remember to label the chemical bottle with your initials and the date received on the chemical bottle!

7. Chemical Storage

7.1 General Considerations for Chemical Storage
Carefully read the label before storing a hazardous chemical. The MSDS will also provide any special storage information and incompatibilities.

7.2 Segregation of Chemicals
Do not store unsegregated chemicals in alphabetical order or incompatible chemicals in close proximity to each other. The amount of space that can be placed between different chemical classes depends on the amount of storage area available in the lab suite. Do not segregate chemical classes into separate rooms unless they will only be used in that room. Segregation that disrupts normal work flow or requires more frequent transport of chemicals between labs will increase the probability of a chemical spill. Use common sense in planning chemical storage areas.

Store dry reagents, liquids reagents and solutions, and compressed gases in separate areas. Within each of these chemical forms, segregate into hazard classes. Once separated into hazard classes, chemicals may be stored alphabetically.

Segregate dry reagents as follows:

- oxidizing solids
- flammable solids
- water reactive solids
- all other solids

Segregate liquid reagents and solutions as follows:

- acid liquids
- caustic liquids
- oxidizing liquids
- perchloric acid solutions
- flammable or combustible liquids
- all other liquids

Segregate compressed gases as follows:

- toxic gases
- flammable gases
- oxidizing and inert gases

Use approved storage containers and safety cans for flammable liquids. Use spill trays under containers of strong corrosive reagents. Do not store liquids above eye level.

7.3 Flammable Liquids Storage

1. Flammable liquids storage cabinets shall be designed and constructed to limit the internal temperature to not more than 325°F when subjected to a 10-minute fire test using the standard time temperature chart set forth in NFPA 251.
2. Storage cabinets shall be constructed of at least No. 18 gauge sheet iron and shall be double walled with 1-1/2 inch air space. Joints shall be riveted, welded, or made tight by some equally effective means. The door shall be provided with a three point lock, and the door sill shall be raised at least 2 inches above the bottom of the cabinet.

3. No more than 60 gallons of a Class I flammable liquids (flash point below 100°F) or Class II combustible liquids (flash point between 100 to 140°F) may be stored in a flammable-liquids storage cabinet.
4. No more than 120 gallons of a Class III combustible liquid (flash point between 140°F and 200°F) may be stored in a flammable-liquids storage cabinet.
5. The NFPA Technical Committee on General Storage of Flammable Liquids considers that providing vents to storage cabinets reduces the limited fire protection provided by such cabinets because a single walled duct will transmit heat faster than a double-walled cabinet. Ventilation of storage cabinets is recommended only when highly odoriferous conditions exist. Ventilation requires a steel duct and an appropriate exhaust fan discharging to an appropriate location outside the building.
6. All flammable-liquids cabinets shall be labeled in conspicuous letters "Flammable - Keep Fire Away."

7.4 Compressed Gases

- Carefully read the label before using or storing compressed gas. The MSDS will provide any special hazard information. Always use the minimum size cylinder required to perform the work.
- Cylinders of compressed gases must be handled as high energy sources. When storing or moving a cylinder, have the cap securely in place to protect the stem. Use suitable racks, straps, chains or stands to support cylinders. Compressed gas cylinders pose a crush hazard to hands and feet.
- Do not expose cylinders to temperature extremes.
- Do not store cylinders or lecture bottles with the regulator in place. If the regulator fails, the entire contents of the gas cylinder may be discharged.
- Always use the correct regulator. Do not use a regulator adapter. Oil or grease on the high pressure side of an oxygen cylinder can cause an explosion. Do not lubricate an oxygen regulator.
- Cylinders of toxic, flammable or reactive gases should be stored and used in a fume hood or with local ventilation.
- Never bleed a cylinder completely empty. Leave a slight pressure to keep contaminants out.
- Always wear safety glasses when handling compressed gases.

7.5 Flammable Gas Cylinders

- The storage of flammable gas cylinders is limited to two (2) type 1 (10" x 50") cylinders per 500 square feet of unsprinklered laboratory space.
- Liquefied flammable gas containers should be limited to two (2) 9" x 30" cylinders per 500 square feet of unsprinklered laboratory space or three (3) 9" x 30" cylinders per 500 square feet of sprinklered laboratory space.

I have read and understand this information.

Employee name	Signature	Date

8. Waste Disposal

This section contains the company's procedures for safe handling and packaging of chemical waste materials generated in the laboratory. The company's policy is zero tolerance for non-compliance with Environmental Regulations. The enclosed procedures must be followed to comply with rules from the U.S. Environmental Protection Agency (EPA) which regulate the disposal of hazardous wastes in a cradle-to-grave fashion.

8.1 Hazardous Waste Defined

Hazardous materials have hazardous characteristics such as: flammable, corrosive, reactive, toxic, radioactive, poisonous, carcinogenic or infectious. In a general sense, these materials are considered hazardous because they present a potential risk to humans and/or the environment. A waste is basically any discarded material. By law, a hazardous waste is defined as a waste, or combination of wastes, that because of its quantity, concentration, or physical, chemical or infectious characteristics may cause or significantly contribute to an increase in serious irreversible, or incapacitating reversible illness or pose a substantial present or potential hazard to human health, safety or welfare or to the environment when improperly treated, stored, transported, used or disposed or otherwise managed. Hazardous waste management plans generally separate waste into three broad groups: radioactive, chemical and biological.

Hazardous waste includes a wide range of material such as discarded commercial chemical products, process wastes and wastewater. Some chemicals and chemical mixtures are hazardous wastes because they are specifically listed by the EPA. Most of the common laboratory solvents are listed wastes. A chemical waste that is not listed by the EPA is still a hazardous waste if it has one or more of EPA's four hazardous characteristics: ignitability, corrosivity, reactivity or toxicity.

8.2 Classification of Chemical Waste

A chemical waste is considered to be a hazardous waste if it is specifically listed by the EPA as a hazardous waste or if it meets any of the four hazardous characteristics below. If a chemical waste is not on the EPA list of hazardous wastes, and does not meet any of the hazardous waste characteristics, it is a non-hazardous waste. For complete definitions of hazardous characteristics of wastes, see the EPA regulation 40 CFR 261-Identification and Listing of Hazardous Waste.

8.2.1 Flammable

A liquid which has a flash point of less than 60°C is an ignitable waste (e. g. Acetone, Methanol). A solid is an ignitable waste if it is capable of causing fire through friction or absorption of moisture, or can undergo spontaneous chemical change which can result in vigorous and persistent burning under standard temperature and pressure (e. g. Benzoyl Peroxide). A substance which is an ignitable compressed gas or oxidizer is an ignitable waste (e. g. Propane, Hydrogen Peroxide).

8.2.2 Corrosive

An aqueous solution which has a pH less than or equal to 2 or greater than or equal to 12.5 (e. g. Hydrochloric Acid, Ammonium Hydroxide), or is a liquid and corrodes steel at a rate greater than 6.35 mm per year at a test temperature of 55°C, is a corrosive waste.

8.2.3 Reactive

A reactive waste is a material that is normally unstable and undergoes a violent chemical change without detonating, can react violently with water to form potentially explosive mixtures or can generate dangerous or possibly toxic gases, vapors or fumes in a quantity sufficient to present a danger to public safety, health or welfare or to the environment; or a material that is capable of detonation or explosive decomposition or reaction at standard temperature (e. g. Picric Acid, Potassium Cyanide, Lithium Aluminum Hydride).

8.2.4 Toxic
A waste that contains one of the constituents in concentrations equal to or greater than the values listed in EPA regulation 40 CFR 261-Identification and Listing of Hazardous Waste is a toxic waste.

8.3 Waste Disposal
Hazardous wastes collected at AKGL will be disposed of at the Hazardous Waste Collection Center (HWCC) located at the Anchorage Regional Landfill. Since AKGL will be producing less than 220 pounds of hazardous wastes per month, they are classified as a Conditionally Exempt Small Quantity Generator (CESQG).

The following rules apply to waste disposal at AKGL. Currently, we have four types of waste barrels (209 L drums in the sample prep room):

1. Organics wastes – including non-halogenated organic solvents;
2. Hazardous solids wastes barrel; and,
3. Corrosive aqueous wastes barrel
4. Non-hazardous aqueous wastes barrel.

The organics wastes barrel is mainly for flammable organics. Examples of organics that should be placed in this barrel are alcohols, acetone, ketones, esters, vacuum pump oil, etc. No more than about 18L of the less flammable constituents should be placed into this barrel. Also, if a large amount (> 5 L) of an ether or a polymerizable material needs to be disposed in this barrel, please see the safety officer first.

The Hazardous solids wastes barrel is for broken glassware, paper towels used to wipe up chemicals, contaminated gloves, etc. Only trace amounts of flammable substances or toxic substances may be disposed in this barrel. This includes acetone, alcohols, N-methyl-2-pyrrolidinone, acids, aniline, amines, etc.

The aqueous wastes barrel is a barrel for any water-soluble compound or solvent. These include aniline reaction solutions, acidic or basic wastes, salts, and others. Small amounts of organic solvents/chemicals can be placed in this barrel (even solvents/chemicals that are not miscible with water), but larger amounts of flammable organics should not be placed in this barrel. Please check with the safety officer before disposing of large amounts (several liters) of very pH basic substances in this barrel.

Many aqueous wastes can be neutralized by adding sodium hydroxide and then can be disposed in the non-hazardous aqueous wastes barrel. Doing so reduces the amount of hazardous wastes produced at AKGL. Please see the safety officer if you think you will produce waste that can go in the non-hazardous barrel.

The following should not be placed into any wastes barrel at a level of more than 5 ppm: dangerous toxins, arsenic, barium, cadmium, chromium, mercury, lead, selenium, silver, copper, nickel, zinc, thallium, sulfides, cyanides, phenol and its derivatives, and PCBs. Please see the safety officer before disposing any of these at any level at all!

Broken mercury thermometers: we have a special wastes jug for broken mercury thermometers. Please see the safety officer for details.

All sharp objects should be treated carefully. Glass can be disposed in the glass disposal boxes. Sharp objects such as razor blades or needles should be disposed of in a sharps container.

Wastes added to the barrels should be recorded in the appropriate wastes logs for each barrel, including what was added and the approximate amount. Wastes that are disposed of regularly, or in large amounts

(> 100 g or 100mL) a needs to be recorded. T Small amounts of chemicals that are already in the barrel do not need to be recorded. The safety officer just needs to know what is in the barrel and the approximate amounts.

No wastes should be disposed down the sink! All glassware, etc. used for chemicals should be rinsed into rinse buckets before rinsing in the sink. A good rinse procedure for most labware is to rinse once in a primary rinse container, rinse a second time in an aqueous rinse container that is not very contaminated, and finally wash in the sink.

I have read and understand this information.

Employee name	Signature	Date

9. Material Safety and Data Sheets

The Material Safety and Data Sheet (MSDS) is the hazard communication tool that provides detailed information on all the important aspects of chemical use, handling and storage.

The OSHA Hazard Communication standard (29 CPR 1910.1200) requires manufacturers to provide MSDSs at no cost to the purchaser. Information in the MSDS is divided into 10, or more, sections.

AKGL requires that all those working in the lab are familiar with the Materials Safety Data Sheets (MSDSs) for the substances they will be using. MSDSs are kept on the bench in the chemistry section.

Section 1 of the MSDS lists information identifying the product and its manufacture. It should include:

- manufacturer's name, address and telephone number
- number to call in case of an emergency
- chemical name and synonyms
- trade name and synonyms
- chemical family and formula
- Chemical Abstract Number (CAS)
- date of preparation

Section 2 describes the various hazardous ingredient(s) contained in the product, the percentages of these ingredient(s) and exposure limits where appropriate. This will include all hazardous chemicals that comprise 1% or greater of the mixture identified. Carcinogenic compounds must be listed if their concentration is greater than 0.1%.

Section 3 describes hazards identification labels and summarizes the hazards of the particular chemical or substance in question.

Section 4 gives first aid procedures in case of exposure to the chemical or substance.

Section 5 describes the fire and explosion hazard for the material. The appropriate extinguishing agent for the fires and special fire fighting procedures will also be listed.

Section 6 gives the necessary information to be taken in case of an accidental release or spill. The steps normally include information on containment, evacuation procedures and waste disposal.

Section 7 describes the handling and storage procedures to be taken with the compound. Information may include statements such as: keep container closed; store in a cool, dry, well ventilated place; keep refrigerated; avoid exposure to sunlight.

Section 8 describes the protective equipment that is required to be worn for the individual working with the chemical. This section normally describes the worst-case scenario. Equipment may include:

- eye protection
- protective glasses
- ventilation

Section 9 describes the physical properties of the material that may include the following:

- boiling point
- specific gravity

- vapor pressure
- percent volatility
- vapor density
- evaporation rate
- solubility
- appearance and odor

Section 10 describes the reactivity data; that is, the materials ability to react and release energy or heat under special conditions or when in contact with certain substances.

Section 11 describes the known health hazard and toxicological data for the material and the exposure limits. Symptoms or the health effects of an overexposure are also listed. This information will help the user and medical personnel if an overexposure has occurred. This information includes:

- threshold limit value (TLV)
- existing medical conditions that maybe aggravated upon exposure
- effects of overexposure (ie vomiting, nausea, skin rashes, weakness etc)
- primary routes of exposure (inhalation, absorption, ingestion)

Section 12 describes general ecological information on the substance.

Section 13 lists disposal considerations, such as how to dispose of the substance.

Section 14 gives transport information.

Section 15 lists any government regulations or restrictions on the substance.

Section 16 describes any special precautions or miscellaneous information regarding the material.

I have read and understand this information.

Employee name	Signature	Date

10. Spill Prevention Control and Countermeasure Plan

Following is a plan for preventing and cleaning up chemical spills.

10.1 Preventing Chemical Spills

1. Chemical Storage

   - Chemicals in regular or small containers should be stored with adequate secondary containment. This includes chemicals in the flammables and corrosive cabinets. Most of these cabinets, however, already have adequate secondary containment.
   - Chemicals in large containers or drums also should be stored in secondary containment. For 20 L solvent cans, the flammables cabinet for these cans already has secondary containment. Otherwise, 20 L solvent cans may be stored temporarily on the large secondary containment mats in the sample prep room. Chemical and waste drums must also be stored on these mats.

2. Chemical Use

   - All chemicals in use should be kept in secondary containment trays whenever possible.
   - Chemicals should be placed in secondary containment when transporting from storeroom or sample prep area.
   - When chemicals are being used near countertop computers or expensive equipment, they ***must*** be kept in secondary containers.

10.2 Response to a Chemical Spill

1. Small Chemical Spill - Chemical spill kits are located in the main chemical lab in the eye-level cabinet next to the hoods (see maps in Appendices). The instruction books for these spill kits are also located in that cabinet. Use the appropriate spill kit to clean up your spill.
2. Major Chemical Spill - If the chemical spill is small enough in volume and does not pose any threat to health or life, use appropriate measures to clean the spill up. Place contents from the cleanup into a waste bin, ***not down the drain***.
3. If the chemical spill poses any threat to health or life, use the following emergency plan:
   - **Call 911** and do not hang up until the operator tells you to do so. Chemtrec (1-800-424-9300) or Chem-Tel (1-800-255-3924) may also be of assistance.
   - ***Get out*** of the region of the spill.
   - If it is safe and practical, close the doors to the region of the spill, notify others of the spill, and guard the area at a safe distance to keep others from entering.
   - If it is safe and practical, secure operations ***not in the danger area*** by shutting down the processes and turning off electrical equipment if flammables and combustibles are involved.
   - Wait in a safe area near the spill to help direct the HAZMAT response team.

11. Personal Contamination

Do what is necessary to protect life. Remain calm. The MSDS for the chemical will contain specific first aid information. **Do not move an injured person** unless they are in further danger. A blanket should be used immediately to protect the victim from shock and exposure. **Get medical attention promptly!** Always provide the ambulance crew and physician the chemical name and any other relevant information.

11.1 Chemical Spills

- Chemicals Spilled Over a Large Area of the Body
  - Quickly remove all contaminated clothing while using the safety shower or other available source of water.
  - Immediately flood the affected body area in cold water for at least 15 minutes.
  - Wash off chemical with water but do not use neutralizing chemicals, unguents, creams, lotions, or salves.
  - Get medical attention promptly.
- Chemicals on the Skin in a Confined Area
  - Immediately flush with cold water. If there is no visible burn, scrub area with warm water and soap. Remove all jewelry to facilitate removal of any residual material.
  - If a delayed action is noted (often the next day), report immediately for medical attention and explain carefully what chemicals were involved.
  - If the incident involves hydrofluoric acid (HF), seek immediate medical attention.
- Chemicals in the Eyes
  - Rinse eyes with plenty of cool water for at least 15 minutes. Simultaneously, check for and remove contact lenses.
  - It is important to hold the eyelid open and roll the eyeball so that water will flow on all surfaces and into the folds surrounding the eyeball.
  - Get medical attention promptly.

11.2 Smoke and Fumes

- Anyone overcome with smoke or chemical fumes should be removed to uncontaminated air and treated for shock. If certified, follow standard CPR protocols. Get medical attention promptly.
- Do not enter the area if a life threatening condition still exists, such as the presence of:
  - oxygen depletion
  - explosive vapors
  - cyanide gas, hydrogen sulfide
  - nitrogen oxides, carbon monoxide
- Extinguish burning clothing by dousing with cold water or use emergency shower or the drop-and-roll technique.
- Remove contaminated clothing. If possible, send clothing with the victim. Wrap injured person to prevent shock. Get medical attention promptly.

I have read and understand this information.

Employee name	Signature	Date

12. Emergency Action Plans

General Emergency Action Plan
The following is a general Emergency Action Plan and is posted, in a condensed form, in several areas throughout the lab and office.

12.1 Steps to take in the case of an emergency:

1. Determine whether or not evacuation is necessary. The final authority for this decision rests with the current safety officer.
2. If evacuation is necessary, meet at the designated evacuation meeting place. AKGL's designated evacuation meeting place is in the front parking lot, or if the front parking lot is not appropriate, across the street in the neighboring parking lot.
3. Call 911 and do not hang up until operator tells you to do so.
4. Qualified safety personnel should administer first aid to injured persons. A list of qualified personnel is given t the endo fthis section.
5. If it is safe and practical, secure operations not in the danger area by shutting down the processes and turning off electrical equipment if flammables and combustibles are involved.
6. Be available to assist the emergency response team (firemen, paramedics, HAZMAT team, etc.).

12.2 Contact Information:
In all cases for major emergencies, CALL 911.

1. In the case of a fire, medical emergency, or domestic problem:
   - Anchorage Police, Fire, and Ambulance: XXX-XXXX
   - Hospital: XXX_XXXX
   - Anchorage County Sheriff's Department: XXX_XXXX
2. In case of a major chemical spill or release:
   - Call Chemtrec (1-800-424-9300)
   - Chem-Tel (1-800-255-3924), or
   - Chemical hazards information center as listed on the chemical's MSDS.
3. Office personnel should also be contacted, in the order listed:
   1. Brian Coyle, President & CEO: 303 304-9661 (cell)
   2. Tim Hinterberger Scientific Director: 9087 317-6250 (cell)
   3. TBD: ZZZZZZZZZ

12.3 Evacuation Plan:

1. Evacuate through the nearest, un-blocked emergency exit (see maps in Appendices).
2. Meet in front of the AKGL building either in the front parking lot or, if evacuation to a further distance is required, in the parking lot across the street.
3. The Security Officer will take roll-call to ensure that all staff have exited the building. In case the Security Oficer is not available to take roll-call, the senior employe onsite will take roll-call.

Persons Trained in First Aid and CPR:

JOHN DOE	5/13/16
JANE DOE	6/13/16

13. Notebooks

AKGL requires that all personnel doing laboratory work maintain a laboratory notebook. New lab notebooks are available in the supplies cabinets.

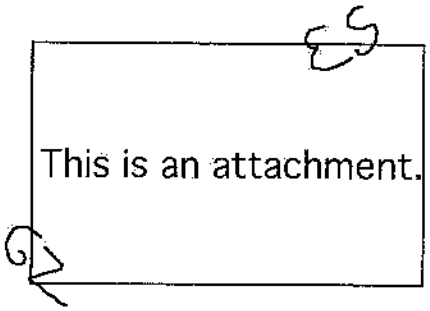
Notes must be taken in ink.

Notes must be legible and complete enough to allow the work to be reproduced. Include the reason for the experiment, i.e., what you are trying to do or find out. Describe the procedure, chemicals, equipment settings, temperatures, times, rates, and any other information necessary. Include the sample numbers. Include the results. Be specific: "bad" does not contain any useful information. Write what happened, such as, "product turned black and precipitated". Include comments and insights.

For analyses of cannabis and canabis products, entries in the notebook are supplemental to the specific analysis forms

Sign and date each page as you complete it. A partial page at the end of the day should also be signed and dated. All blank areas must be crossed out with a "Z".

At least once a week, all newly filled pages of the notebook must be countersigned and dated by a technically competent co-worker, i.e. one who can understand what you wrote. All attachments must be initialed on the border of the attachment by both you and the co-worker as in the example below.
Keep a table of contents. This should be kept up to date each week.



Notebooks remain the property of AKGL.

I have read and understand this information.

Employee name	Signature	Date
	Signature	Date

Appendix A. Safety Training

AKGL requires employees who work in the lab to receive training in safety and personal protective equipment. The following online course covering basic topics of lab safety is required for new employees

http://labsafetyworkspace.org/training/introduction-laboratory-safety

This introductory program covers essential topics of laboratory safety applicable to a wide range of laboratories. It is a 2 hour flash audio and video presentation. You will need to watch, read and listen to the presentation through completion and complete the quiz at the end to receive credit.

Additional online courses focused on more specific topics of lab safety are listed here:

http://labsafetyworkspace.org/training-course-list

The training shall include the following subjects:

- When PPE is necessary to be worn.
- What PPE is necessary .
- How to properly don, doff, adjust, and wear PPE.
- The limitations of the PPE.
- The proper care, maintenance, useful life, and disposal of the PPE.

I have been trained in the use of the following (initial).

_____ fire extinguishers	_____ safety shower
_____ gloves	_____ hoods
_____ face shields	_____ dust masks
_____ safety glasses and goggles	_____ chemical spill kits
_____ eye washes	_____ labeling

_____	_____	_____
Employee name	Signature	Date

The above named employee has demonstrated to me that s/he understands the components of the PPE program and how to use PPE properly.

_____	_____	_____
Safety Officer	Signature	Date

Appendix B. Accident Report Forms

All small businesses subject to OSHA and with 11 or more employees are required by law to maintain records of employee injuries and illnesses. Records must be kept on every occupational death, every nonfatal occupational illness, and nonfatal occupational injuries which involve one or more of the following: loss of consciousness, restriction of work or motion, transfer to another job, or medical treatment (other than first aid). An occupational injury is defined as any injury such as a cut, fracture, sprain, amputation, etc. which results from a work accident or from an exposure involving a single incident in the work environment. An occupational illness is any abnormal condition or disorder, other than one resulting from an occupational injury, caused by exposure to environmental factors associated with employment. It includes acute and chronic illnesses or diseases which may be caused by inhalation, absorption, ingestion, or direct contact. Injury and illness records must be maintained at a worksite for a five-year period and made available to employees and OSHA inspectors. An OSHA 300 log of recordable injuries and illnesses is kept on file and a summary of this log is posted yearly for the previous year's injuries and illnesses. This log is posted in the coffee room.

The following page gives an example of an accident report form. These forms are to be filled out for all major accidents in the workplace and are located in the coffee room on the posting board. The Safety Officer should be notified of any major accidents. Major accidents may or may not include physical injury. Injuries that require medical treatment (more than just first aid) must be reported to the Safety Officer and an OSHA form 301 must be completed.

Employee name	Signature	Date

Form: Notice of Accident

(In accordance with AS 18.60.058)

_____, was involved in an on-the-job accident

Employee name

at approximately _____; on _____, 20_____.

What happened and where: _____

_____

_____

_____ _____ _____

Employee name Signature of Employer or Agent Date

_____

Employee's social security number

Appendix D. List of Hazardous Materials and Equipment at AKGL

Hazardous Materials:	**Permission Given by:**
methanol	Safety Officer
ethanol	
diethy ether	
hydrocloric acid	
hydrofluoric acid	
sulfuric acid	
ammonium nitrate	
compressed gasses	

Hazardous Equipment:	**Permission Given by:**
Operating the compressed cylinder trolley	Safety Officer
Operating the centrifuge	
Operating the incubator	

Any person wishing to use the above mentioned chemicals or equipment needs to receive permission from the appropriate people. Some of the equipment will require special training. All questions regarding the use of hazardous chemicals should be addressed to the safety officer.

Appendix E. List of Problematic Chemicals

(not comprehensive)

Chemicals that must be stored no longer than three months:

Di-isopropyl ether
Divinylacetylene
Potassium metal
Potassium amide
Sodium amide
Vinylidene chloride

Chemicals that must not be stored over six months to one year:

Cyclohexene
Decalin
Diethyl ether
Diethylene glycol dimethyl ether
Dioxane
Ethylene glycol dimethyl ether
Ethylene glycol ether acetates
Ethylene glycol monoethers
Furan
Methyl isobutyl ketone
Tetrahydrofuran
Any other ethers

Chemicals that are especially dangerous:

Hydrofluoric acid
Perchlorates
m-cresol
benzidine
bromine
acrylonitrile
Peroxides

Special Waste Disposal

These chemicals are difficult to dispose of and must not be disposed in the normal waste containers:

Arsenic compounds
Barium compounds
Cadmium compounds
Chromium compounds
Mercury compounds
Lead compounds
Selenium compounds
Silver compounds
Copper compounds
Nickel compounds
Zinc compounds
Thallium compounds
Cyanides
Sulfides
PCB's
Phenol containing compounds

Example Form: Permission Form for Hazardous Materials

Valid Dates: _____ to _____	Lab Location:
Hazardous Material (s):	
Specific Tasks Performed With These Materials:	

I have read the Materials Safety Data Sheets (MSDSs) for the substances I will be using and will return them to the proper places after use.

Used By: _____. _____ _____
Employee name Signature Date

I have trained _____ in the proper use of the hazardous materials specified.

Trained by: _____. _____ _____
Name Signature Date

Example Form: Permission Form for Equipment

Valid Dates: _____ to _____	Lab Location:
Equipment You Want to Use:	
Specific Tasks Performed With This Equipment:	

I have read and understand the information in this section:

_____ _____ _____

Employee name Signature Date

I have trained _____ in the proper use of the equipment specified.

_____ _____ _____

Trainer name Signature Date

Procedures for Sample Receiving, Tracking and Disposal

AK Green Labs LLC

Updated May 2016

1. Sample Receiving, Tracking and Disposal

1.1 Objective

This section provides guidelines for the receiving, tracking, storage and disposal of cannabis products received by AK Green Labs (AKGL) for testing.

1.2 Marijuana Handler Permits

All employees of AKGL who handle cannabis or cannabis products must have a current Marijuana Handler's Permit. This is a condition of employment and AKGL management will ensure compliance by employees by notifying them of expiration and renewal dates for this permit and tracking permit renewals.

1.3 Receiving Samples

Cannabis product samples can be received at the front or rear entrance of AKGL. Samples brought to the front entrance will be transported to the Sample Receiving area, a secure room of AKGL, for processing. The Sample Receiving area is located in the secure room at the back of the premises. If a sample is received at the rear entrance, the person dropping it off must go around to the front entrance to fill out the paperwork, because only the sample will be allowed into the Sample Receiving area.

1.3.1 Sample Integrity

It is the responsibility of the analyst to maintain the integrity of the cannabis product at all times while in his/her custody. All cannabis samples must be protected from loss, cross-transfer, contamination and/or deleterious change.

1.3.2 Commercial Samples

All samples of Commercial Products that are transferred to AKGL must arrive in an approved container with a tamper-proof seal, marked with a unique METRC identifier and accompanied by a METRC Manifest. If the seal, the METRC identifier or the Manifest is missing then the sample will not be accepted by AKGL. As soon as practical after a sample is received, and before any analysis is started, the required information must be entered into the METRC inventory tracking system. Including but not limited to:

- Customer name
- METRC tracking number
- Condition of tamper seal

- Type of product
- Sample weight
- Sample volume for liquids

1.3.3 Sample Receiving & Tracking Form

When a cannabis product is received at AKGL, it is weighed, photographed and other relevant information recorded on the AKGL *Sample Receiving & Tracking* form. Including but not limited to:

- Customer name
- Customer ID (optional)
- LIMS tracking number
- Type of product
- Sample weight
- Sample volume for liquids
- Description of sample

A brief description of the sample should include the general nature and appearance of the sample as well as any notable or unusual characteristics of the product sample. The use of abbreviations is acceptable as long as they are commonly used or are included in the Abbreviations section of this document. An internal Laboratory Information Management System (LIMS) tracking number is assigned to samples so they can be tracked through the AKGL LIMS.

After it is filled out, this form is placed with the sample (e.g. in a ziploc bag or other container) and remains with it while it is on the AKGL premises. This form is also used to maintain a record of every time that the sample is accessed while in storage.

1.3.4 Manifest Discrepancies

Information gathered for the *Sample Receiving & Tracking* form should match the information in METRC, on the customer's METRC manifest. If there are significant differences between the METRC entries and the samples themselves, such as missing samples or sample weights, the analyst's supervisor will be notified as soon as possible. Efforts will be made to clarify the information through METRC and/or the customer will be contacted to help determine the cause of the discrepancy. Generally, these cases will be investigated in-house with notification going to the Laboratory Director. The facts surrounding the discrepancy will be noted as part of the case record at the conclusion of the report.

1.4 Internal Tracking of Samples

Samples submitted to AKGL for analysis will be tracked internally through the AKGL LIMS. The storage and movement of product samples while on the AKGL premises will also be tracked by the table comprising the lower part of the *Sample Receiving & Internal Tracking* form. This sheet will remain with the product sample while it is at the AKGL premises. Any time a sample is accessed in storage, e.g. when part of a sample is removed from storage for pre-test preparation, the following information must be recorded in the Tracking table of the *Sample Receiving & Tracking* form:

- Date
- Purpose
- Analysts Initials
- Amount Retained
- Amount Returned

This form is initialed and dated by the analyst handling the sample. If there is not enough space in the *Tracking* section of this form, additional sheets can be attached to record the movements of a sample while at AKGL.

1.5 Sample Storage

After a sample is checked in, the required information is recorded on the *Sample Receiving & Tracking* form, entered into METRC and the AKGL LIMS, the sample is placed into the Daily Bin of the Sample Receiving area. Prior to testing, samples are kept in a secure storage area, in bins that are labeled with the date on which the samples were received. Samples will remain in the storage area until retrieved for pre-analysis preparation and subsequent analysis.

Samples will remain in storage until all requested tests have been completed and the results of these tests have been reviewed. When the requested testing has been carried out but not yet reviewed, unused portions of the test samples may be placed in the Under Review bin where they will remain until the analysis results have passed technical and administrative review. After the analyses have passed review, the remaining portion of the sample should be disposed of as soon as practical and should not be kept past a maximum of 30 days. Waste barrels for disposing of unused samples are located at the rear of the secure area. (More information on the waste barrels at AKGL can be found in Section 8 of the AK Green Labs Chemical Hygiene Plan.)

1.6 Transfer of Product Samples

In some instances it may be necessary to transfer a marijuana product sample to another facility, e.g.

for re-testing. Transfers of marijuana product samples must comply with all regulations pertaining to transfers. Before the sample leaves AKGL, the required information must entered into the METRC system, a manifest generated that will accompany the sample and the sample placed in an approved contained with a tamper-evident seal.

For the purpose of internal tracking, the AKGL *Sample Transfer* form should also be filled out before the sample leaves the premise.

1.7 Disposal of Product Samples

Marijuana waste remaining after the testing is completed on a sample, will be disposed of by mixing it with used organic solvents and disposing of it in the organic wastes barrel - Rendering it totally unfit for consumption. (For more information on this barrel and the other waste barrels at AKGL see Section 8 of the AK Green Labs Chemical Hygiene Plan.) Trace amounts of waste marijuana, e.g. on containers or bags, may also be mixed with non-hazardous solid waste for disposal.

The remaining, untested portions of all Commercial samples must be disposed of in accordance with the regulatory requirements. Three days notice must be given in METRC, or by other approved methods, before Commercial samples are disposed. In addition, disposal of all Commercial samples must be carried out in view of the video surveillance system.

Note: Hazardous wastes produced at AKGL will be disposed of at the Hazardous Waste Collection Center located at the Anchorage Regional Landfill.

Sample Receiving & Tracking

AK Green Labs LLC
2509 Fairbanks Street, Suite A
Anchorage, Alaska 99503
907 770-9997

Date	
Customer Name	
Company	
Phone	
eMail	
Received by:	

Sample Name:

Commercial Product? No Yes →

Commercial Product Tracking

METRC #: _____

Sample Type:

Condition of Security Seal:

Test Options (mark only the tests requested)

THC, CBD, CBN	
Residual Solvents	
Microbiological Screening	
Terpene Profile	

AKGL LIMS # _____

Sample weight _____ **Volume:** _____ (liquids only)

Describe sample:

Comments:

Special Handling:

Sample Tracking - Internal (Add sheets as needed to track internal transfers or transfer to another facility.)

Date	Purpose	Amount Retained	Amount Returned	Analyst Initials

Sample Tracking - Continuation

AK Green Labs LLC
2509 Fairbanks Street, Suite A
Anchorage, Alaska 99503
907 770-999

METRC # _____

AKGL LIMS # _____

Sample Tracking Internal – continued

Date	Purpose	Amount Retained	Amount Returned	Analyst Initials

Sample Transfer

AK Green Labs LLC
2509 Fairbanks Street, Suite A
Anchorage, Alaska 99503
907 770-999

METRC #
AKGL LIMS #

Customer:	**Sample Name:**
	Type:
Destination:	

Sample weight: _____ **Volume:** _____ (liquids only)

Describe sample:

Reason for transfer:

Released by:	**Date:**
Print name:	

TIMOTHY J. HINTERBERGER

WWAMI School of Medical Education
University of Alaska Anchorage
3211 Providence Drive
Anchorage, AK 99508

Office phone: (907) 786-4632
Fax: (907) 786-4700
E-mail: tjhinterberger@uaa.alaska.edu

EDUCATION

1987	Ph.D. in Biology Department of Cell and Structural Biology University of Illinois, Urbana *Advisor: Dr. JoAnn Cameron*
1981	M.S. in Biology Department of Anatomical Sciences University of Illinois, Urbana
1976	B.S. in Biology University of Illinois, Urbana

PROFESSIONAL EMPLOYMENT

Faculty

2013-present	Professor WWAMI School of Medical Education University of Alaska Anchorage
2011-2013	Associate Professor WWAMI School of Medical Education University of Alaska Anchorage
1998-2011	Associate Professor Biomedical Program and Department of Biological Sciences University of Alaska Anchorage
1992-1998	Assistant Professor Biomedical Program and Department of Biological Sciences University of Alaska Anchorage

WWAMI Affiliate Appointment

1995-present	Affiliate Faculty Member Department of Biological Structure University of Washington School of Medicine

Postdoctoral

1989-1992	Purdue University Department of Biological Sciences *Advisor: Dr. Stephen F. Konieczny*
1987-1989	University of Michigan Department of Anatomy and Cell Biology *Advisor: Dr. Kate F. Barald*

RESEARCH PUBLICATIONS

Hinterberger, T.J. (2010) A conserved MRF4 promoter drives transgenic expression in Xenopus embryonic somites and adult muscle. *Int. J. Dev. Biol.* 54:617-625

Larson, K., E. Coleman, and T. Hinterberger (2008) Expression of MRF4 in cranial regions of Xenopus laevis embryos. *Ethnicity & Disease* 18 (suppl. 1):51-52.

Ataian, Y., Owens, J., and Hinterberger, T. (2003) *MRF4* gene expression in Xenopus embryos and aneural myofibers. *Developmental Dynamics* 226:551-554.

Kerkvliet, C.M., and T.J. Hinterberger (1997) Distal regulatory regions of the rat *MRF4* gene. *Biochem. Biophys. Res. Comm.* 237:170-176.

Naidu, P.S., D.C. Ludolph, R.Q. To, T.J. Hinterberger, and S.F. Konieczny (1995) Myogenin and MEF2 function synergistically to activate the *MRF4* promoter during myogenesis. *Molec. Cell. Biol.* 15:2707-2718.

Hinterberger, T., J.L. Mays, and S.F. Konieczny (1992) Structure and myofiber-specific expression of the rat muscle regulatory gene *MRF4*. *Gene* 117:201-207.

Hinterberger, T.J., D.A. Sassoon, S.J. Rhodes and S.F. Konieczny (1991) Expression of muscle regulatory factor MRF4 during somite and skeletal myofiber development. *Dev. Biol.* 147:144-156.

Hinterberger, T.J., and K.F. Barald (1990) Fusion between myoblasts and adult muscle fibers promotes remodeling of fibers into myotubes *in vitro*. *Development* 109:139-148.

Cameron, J.A., A.R. Hilgers and T.J. Hinterberger (1986) Evidence that reserve cells are a source of regenerated adult newt muscle *in vitro*. *Nature* 321:607-610.

Cameron, J.A., and T.J. Hinterberger (1984) Regional differences in the distribution of myogenic and chondrogenic cells in axolotl limb blastemas. *J. Exp. Zool.* 232:269-275.

Hinterberger, T.J., and J.A. Cameron (1983) Muscle and cartilage differentiation in axolotl limb regeneration blastema cultures. *J. Exp. Zool.* 226:399-407.

INVITED REVIEW

Hinterberger, T.J., and J.A. Cameron (1990) Myoblasts and connective tissue cells in regenerating amphibian limbs. *Soviet J. Dev. Biol. (Ontogenez)* 21:241-253

RECENT ABSTRACTS

Haughey, C., C. Albert, D. Stewart, C.H. Wilson and T. Hinterberger (2012) Evidence of a role for the muscle regulatory factor MRF4 in neural development in *X. laevis*. Proceedings of the 14th International Xenopus Conference, p. 112.

Odle, E.,Watts, B., Ribas, R., Carvajal, J., and Hinterberger, T. (2010) Evolutionary Analysis of the MRF4-Myf5 Gene Locus. Proceedings of the 13th International Xenopus Conference (http://www.xenopus2010.org/xenopus2010/Index.do)

Bonnecaze, A.K., and T. Hinterberger (2008) A cell culture model for effects of branched chain amino acids on protein synthesis in skeletal muscle. Proceedings of the 4th Annual University of Alaska Biomedical Research Conference, p. 5 (http://biomed.uaa.alaska.edu/2008_UABRC_Program_Booklet.pdf)

Cheatwood, J., E. Coleman, C. Strong, and T. Hinterberger (2008) Role of *MRF4* in *Xenopus* laevis Embryonic Development. Proceedings of the 4th Annual University of Alaska Biomedical Research Conference, p.11 (http://biomed.uaa.alaska.edu/2008_UABRC_Program_Booklet.pdf)

Hinterberger, T. (2008) *MRF4* Expression and Regulation in Xenopus. Northwest Regional Developmental Biology Conference.

Coleman, E., and T. Hinterberger (2007) Neural expression of MRF4 in Xenopus laevis. Late abstracts, the American Society for Cell Biology 47th Annual Meeting, p. 78 (http://ascb.org/meetings/abstractscd/pdfs/late.pdf)

Hinterberger, T.J., and T.C. Wright (2004) Transgenic analysis of Xenopus MRF4 gene regulation. *Dev. Biol.* 271:565.

INVITED SEMINARS

University of Alaska Anchorage, Department of Biological Sciences, October 2007
University of Alaska Fairbanks, Institute of Arctic Biology, January 2002
University of North Dakota College of Medicine, Department of Anatomy, February 1998
University of Illinois Urbana, Department of Cell and Structural Biology, August 1997
Indiana University–Purdue University Indianapolis, Department of Biology, August 1997
University of Alaska Fairbanks, Biochemistry and Molecular Biology Program, March 1995

RESEARCH FUNDING (as Principal Investigator unless noted)

Source: University of Alaska INBRE (NIH-funded)
Project title: Functional Significance of Altered HCN Channel Expression in the Turtle Pacemaker
Role: co-PI
Funding period: Sep 1, 2015 to Aug 31, 2016
Amount: $125,000

Source: National Institutes of Health R15 (Academic Research Enhancement Award)
Project title: Expression and Regulation of MRF4 in Xenopus
Funding period: Aug 12, 2009 to July 31, 2012 (no-cost extension to July 31, 2013)
Amount: $197,600

Source: University of Alaska Anchorage (Chancellor's Fund)
Project title: Gene response to muscle denervation in Xenopus
Funding period: Academic year 2008-2009
Amount: $21,000

Source: University of Alaska BRIN (NIH-funded)
Project title: Regulation of MRF4 expression in Xenopus laevis
Funding period: May 15, 2003 to May 14, 2004
Amount: $21,352

Source: National Institutes of Health R15 (Academic Research Enhancement Award)
Project title: Expression and Function of Myogenic Regulatory Factor MRF4
Funding period: May 15, 1997 to May 14, 2000
Amount: $95,703

Source: American Heart Association, Alaska Affiliate
Project title: Institutional Award to Support Graduate Student Research Fellowships
Funding period: July 1, 1996 to June 30, 1999
Amount: up to $151,200 (depending on number of trainees)

Source: American Heart Association, Alaska Affiliate
Project title: Institutional Award for Graduate Student Support
Funding period: July 1, 1995 to June 30, 1996
Amount: up to $50,400 (depending on number of trainees)

Source: American Heart Association, Alaska Affiliate
Project title: Analysis of MRF4 Gene Expression in Adult Striated Myofibers In Vitro
Funding period: July 1, 1993 to June 30, 1994 (no-cost extension to June 30, 1995)
Amount: $29,997

Source: University of Alaska NIH-funded Biomedical Research Support Grant
Project title: Changes in Gene Expression in Skeletal Muscle Fibers Following Myoblast Fusion
Funding period: December 1, 1992 to September 30, 1993
Amount: $9,875

Source: University of Alaska Anchorage Faculty Development Fund
Project title: A Cell Culture Model of Muscle Fiber Gene Regulation
Funding period: January 1, 1993 to June 30, 1993
Amount: $4500

GRADUATE STUDENTS TRAINED IN MY LABORATORY

Steven J. Sivils, M.S. (2003) *Dissertation title:* Use of mRNA Differential Display to Identify Genes Involved in Early Heart Development in *Xenopus laevis*
Current position: Medical doctor, Anchorage

Sara S. Dirscherl, M.S. (2001) *Dissertation title: MRF4* Gene Regulation In *Xenopus laevis*
Current position: Director of Operations, National Jewish Health, Denver CO

Yeganeh Ataian, M.S. (2000) *Dissertation title:* Response of *Xenopus MRF4* Gene to Innervation and Neuromuscular Activity
Current position: President, Alaska Women's Network

Carol M. Kerkvliet, M.S. (1996) *Dissertation title:* Isolation and Characterization of an Enhancer Region Upstream of the Rat *MRF4* Gene
Current position: Assistant Area Management Biologist, Alaska Dept. of Fish & Game

SUMMARY OF UNIVERSITY SERVICE ACTIVITIES SINCE 1997

Service at UAA and UA System levels:

97-98: UAA Radiation Safety Officer (40 hours); member, Institutional Animal Care and Use Committee (1 hour); member, Institutional Biosafety Committee (1 hour), chair, CAS Faculty Committee for 1998 Performance Adjustment Evaluations (50 hours).

98-99: UAA Radiation Safety Officer (30 hours); member, Institutional Animal Care and Use Committee (1 hour); member, Institutional Biosafety Committee (1 hour); participant in planning the proposal to the National Science Foundation for support of Alaska EPSCoR (40 hours); co-chair, United Academics–University of Alaska joint labor-management

committee on workload issues (40 hours); judge, USUAA Spring 99 Essay Contest (4 hours).

99-00: UAA Radiation Safety Officer (30 hours); member, Institutional Animal Care and Use Committee (1 hour); member, Institutional Biosafety Committee (1 hour).

00-01: member, Institutional Animal Care and Use Committee (1 hour); member, Institutional Biosafety Committee (1 hour); submitted proposals for Univ of Alaska Initiative funding (30 hours); Freshman Early Admission advising (1 hour).

01-02: chair, Alaska WWAMI Review Committee (100 hours); participant in planning the Ecology/Biomedical Health and Integrated Sciences buildings (30 hours); member, UAA Faculty Evaluation Task Force (15 hours); member, UAA Faculty Senate (15 hours); member, UAA Graduate Academic Board (10 hours); chair, CAS Faculty Peer Review Committee, Mathematics & Natural Sciences (Other Ranks) (6 hours); submitted proposal for UA Initiative funding (4 hours).

02-03: member, UAA Faculty Senate (20 hours); member, UAA Graduate Academic Board (30 hours); chair, CAS Faculty Peer Review Committee, Mathematics & Natural Sciences (Other Ranks) (8 hours); submitted proposals for Univ of Alaska initiative funding (16 hours).

03-04: president-elect, UAA Faculty Senate (5-10 hours per week); chair, CAS Faculty Peer Review Committee, Mathematics & Natural Sciences (Other Ranks) (30 hours); submitted proposals for Univ of Alaska initiative funding (15 hours).

04-05: president, UAA Faculty Senate (10 hours per week); chair, Univ of Alaska Faculty Alliance (10 hours per week); member, UAA Academic Master Plan Committee (2 hours per week); member, Search Committee for University of Alaska Vice President for Academic Affairs (30 hours); co-chair, review panel for UAA Chancellor's Fund awards (50 hours); member, UAA Assembly (2 hours per month).

05-06: past president and executive board member, UAA Faculty Senate (5 hours per week); member, University of Alaska Faculty Alliance (3 hours per week); member, UAA Strategic Planning Committee (2 hours per month); member, Search Committee for UAA Provost (100 hours); member, UAA Planning & Budget Advisory Committee (20 hours); member, Graduate Academic Board (6 hours per month); member, Academic Steering Committee on Distance Education (5 hours per month); submitted proposal for UAA initiative funding (12 hours); attended workshop on student feedback of instruction, held by IDEA Center of Kansas State Univ, Feb 10-11, 2006.

06-07: member, University of Alaska Faculty Alliance (3 hours per week); member, UAA Faculty Senate (6 hours per month); helped to coordinate introduction of and train faculty in use of the Student Reaction to Instruction and Courses system (30 hours); member, UAA Strategic Planning Subcommittee of PBAC (2 hours per month); member, Graduate Academic Board (6 hours per month); member, review committee for Alaska Heart Institute undergraduate research awards (12 hours); member, review committee for UnAc/OAA faculty travel grants (6 hours).

07-08: member, UAA Strategic Planning Subcommittee of PBAC (2 hours per month); member, review committee for UnAc/OAA faculty travel grants (6 hours); faculty advisor, VOX:

Voices of Planned Parenthood student organization (6 hours); UA/UnAc Joint Health Care Committee (25 hours).

08-09: member, UAA Institutional Animal Care and Use Committee (10 hours); reviewer, Chancellor's Fund proposals (10 hours); member, review committee for UnAc/OAA faculty travel grants (6 hours); faculty advisor, VOX: Voices of Planned Parenthood student organization (6 hours); UA/UnAc Joint Health Care Committee (25 hours).

09-10: member, UAA Faculty Senate (20 hours); UA/UnAc Joint Health Care Committee (35 hours); member, UAA Institutional Animal Care and Use Committee (10 hours); faculty participant, 4th Annual University of Alaska Premed Summit, 27 Mar 2010 (4 hours); member, UAA Vivarium Users and Managers Committee (6 hours); member, review committee for UnAc/OAA faculty travel grants (6 hours).

10-11: sabbatical leave

11-12: member, Graduate Academic Board, (6 hours per month); UAA Vivarium Users and Managers Committee (6 hours); member, UAA Faculty Senate's Budget, Planning and Facilities Advisory (BPFA) Committee (6 hours).

12-13: co-organizer, 8th University of Alaska Biomedical Research Conference (40 hours); member, Graduate Academic Board (30 hours); interim Chair, UAA Institutional Animal Care and Use Committee, Spring 2013 (20 hours); member, review committee for Alaska Heart Institute undergraduate research awards (8 hours); member, College of Health Interprofessional Education Committee (20 hours); member, UAA Vivarium Users and Managers Committee.

13-14: co-chair, College of Health Interprofessional Education Committee;

14-15: member, Senate Budget, Planning & Facilities Advisory Committee.

15-16: member, Senate Budget, Planning & Facilities Advisory Committee; member, Institutional and Unit Leadership Review Committee.

Departmental service:

97-98: Member, Graduate Admissions Committee, Department of Biological Sciences (10 hours).

98-99: member, Search Committee for Biological Sciences physiology faculty position (40 hours); member, Graduate Admissions Committee, Department of Biological Sciences (4 hours).

99-00: member, Search Committee for Biological Sciences faculty positions (50 hours); member, Graduate Admissions Committee, Department of Biological Sciences (4 hours).

00-01: assisted search committee for Biomedical Program Director (20 hours).

01-02: chair, Search Committee for WWAMI pathology faculty position (30 hours); member, Biological Sciences Safety Committee (8 hours).

02-03: member, Biological Sciences Safety Committee (8 hours).

04-05: member, WWAMI medical school applicant eligibility review committee (10 hours)

07-08: co-organizer of 4th Annual University of Alaska Biomedical Research Conference (40 hours); chair, search committee for WWAMI Associate Director (60 hours); presented Biological Sciences departmental seminar, 5 Oct 07 (6 hours).

08-09: member, Search Committee for Biomedical research laboratory technician (20 hours); member, WWAMI medical school applicant eligibility review committee (10 hours).

09-10: participated in meetings between WWAMI and Engineering faculty to explore possible research collaborations, Mar & Apr 2010 (6 hours); faculty coordinator for WWAMI visiting lecturers (30 hours).

10-11: sabbatical leave

11-12: member, WWAMI medical school applicant eligibility review committee (10 hours); member, Search Committee for WWAMI Director (60 hours); assisted hosting UA Board of Regents' visit to WWAMI facilities in Health Sciences Building, 7 June 12 (2 hours); attended College of Health all-college meeting, 7 Nov 11 (2 hours).

12-13: led UAA campus tours for WWAMI applicants, Feb 4, 5 & 7, 2013.

13-14: initiated and participated in an effort by UAA WWAMI faculty to design a framework for UWSOM Curriculum Renewal (15 hours total); member, Search Committee for new WWAMI faculty member (6 hours).

SUMMARY OF PROFESSIONAL SERVICE ACTIVITIES

In addition to the following year-specific activities, I have maintained continuous memberships in the Society for Developmental Biology and the American Association for the Advancement of Science, and I held membership in the American Society for Cell Biology until 2001.

97-98: Member, Affiliate Study Group (grant proposal reviewer), American Heart Association (40 hours).

98-99: Member, Affiliate Study Group (grant proposal reviewer), American Heart Association (60 hours).

99-00: member, Affiliate Study Group (grant proposal reviewer), American Heart Association (60 hours); manuscript reviewer for *Molecular Biology Reports* (20 hours).

00-01: member, Affiliate Study Group (grant proposal reviewer), American Heart Association (60 hours)

01-02: co-organizer, 2nd Alaska Summer Neuroscience Conference, Fairbanks (40 hours); member, Affiliate Study Group (grant proposal reviewer), American Heart Association (50 hours).

02-03: member, Research Committee, American Heart Association, Northwest/Pacific Mountain Affiliate (20 hours).

03-04: member, Research Committee, American Heart Association, Northwest/Pacific Mountain Affiliate (20 hours).

04-05: member, Research Committee, American Heart Association, Northwest/Pacific Mountain Affiliate (20 hours).

05-06: member, Research Committee, American Heart Association, Pacific Mountain Affiliate (20 hours).

09-10: manuscript review for the *International Journal of Developmental Biology* (15 hours).

SUMMARY OF PUBLIC SERVICE ACTIVITIES

98-99: lecturer, UAA Science and Society lecture series, 12 Oct 1998 (30 hours).

02-03: incorporator & chair, board of directors, Alaska Drug Policy Forum.

04-05: presented scientific testimony to the Senate Judiciary Committee and the Senate Health, Education & Social Services Committee of the Alaska State Legislature (50 hours); arranged testimony by other internationally respected scientists (10 hours).

05-06: wrote an affidavit in support of a lawsuit by the ACLU of Alaska in the Superior Court (30 hours).

06-07: speaker, ACLU of Alaska Membership Conference (6 hours); member, Board of Directors, Alaska Public Employees Association (15 hours).

07-08: member, Board of Directors, Alaska Public Employees Association (15 hours).

08-09: member, Board of Directors, Alaska Public Employees Association (15 hours).

09-10: member, Board of Directors, Alaska Public Employees Association (20 hours); lecture presentation, "Why are our brains wired the way that they are?" for UW/Providence Hospital Mini Med School series, 6 Oct 2009 (10 hours), recorded and broadcast on KSKA, 8 Oct 2009.

10-11: sabbatical leave

12-13: member, Alaska Public Employees Association political action committee (10 hours); member, Initiative Committee for PSUM13 (20 hours).

13-14: presented a public talk for Anchorage Science Pub at the Taproot, 13 Apr 2014, title: "Don't Just Say 'Drugs'" (30 hours total); member, Alaska Public Employees Association political action committee (10 hours).

Dr. Benjamin Russell Mattes

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PROFILE

Upon completion of his Ph.D. at UCLA, Mattes accepted a position as a member of the technical staff in the Chemical Science and Technology Division at Los Alamos National Laboratory (LANL) and from 1992-1998 he served as Technical Project Leader. In their work, his research group created and discovered a number of different materials for industrial and defense applications resulting in numerous patents and publications in scientific literature. Among the projects, Mattes cites the examples of 'sun' glasses for soldiers developed to protect the human eye from the damaging effects of high-energy laser pulses and gas separation membrane systems that recover enriched and purified oxygen from air.

Mattes taught courses as a visiting Assistant Professor of Chemistry at UCLA on occasion during the 1990's and from 1993-1998 he spent 2-3 months per year traveling to National Academy of Science Institutes and Chemical and Biological Warfare Development Centers all over Russia working with the United States Department of Energy (DOE) program called Initiatives for Proliferation Prevention. "This was essentially a U.S. funded Defense Conversion program,which coupled weapons scientists at DOE labs with their Russian counterparts and a U.S. industrial partner for the purpose of converting Weapons of Mass Destruction technologies into peaceful commercial products.

In 1998, Mattes resigned his position at LANL to establish Santa Fe Science and Technology Corporation (SFST). As the founder, President and CEO of SFST, Mattes, assembled and led an international team of thirteen Ph.D. scientists and engineers focused on developing the unique properties of electrically conducting polymers (ECP) for commercial and national defense applications.

Mattes' company obtained ISO 9001 certification for its manufacturing process and operated under a multi-million dollar contract(s) with the Defense Advanced Research Projects Agency (DARPA) to mature the fiber manufacturing process and explore the ECP material potential as electrochemical mechanical actuators, i.e., artificial muscles for advanced robotics applications.

Mattes has more than 100 publications in refereed scientific journals and 30 patents and has made technical presentations at over 100 national and international science conferences, universities, and private industrial groups. He has served as a consultant for the Defense Science Research Committee (DSRC), the Monsanto Chemical Company and Spectrum Laboratories and is a member of the advisory boards of the UAF Center for Nanosensor Technology and the UCLA Center for Nanoscience and Technology.

Mattes sold Santa Fe Science and Technology Corporation in 2015 and returned to Alaska.

EDUCATION

Institution	Degree	Date	Field of Study
University of Alaska, Fairbanks, Alaska	BS	05/1982	Psychology
University of Alaska, Fairbanks, Alaska	BS	05/1983	Chemistry
University of Alaska, Fairbanks, Alaska	MS	05/1986	Natural Products Chemistry
University of California, Los Angeles, CA	Ph.D.	05/1992	Inorganic Chemistry
Los Alamos National Laboratory, Los Alamos, NM		05/1993	Post-Doctoral Fellow

EXPERIENCE

1998-2014 President and CEO, Santa Fe Science and Technology, Inc.; Santa Fe, NM
1992-1998 Member of the Technical Staff, Los Alamos National Lab; Los Alamos, NM
1986-1988 Research Scientist, Lockheed Aeronautical Systems; Santa Clarita, CA
1984-1986 Research Assistant, University of Alaska; Fairbanks, AK

AWARDS AND HONORS

The Los Alamos National Laboratory Entrepreneur of the Year Award (February 2000)
The Los Alamos National Laboratory Technical Achievement Award (September 1998)
The Los Alamos National Laboratory Technical Achievement Award (April 1996)
Herbert Newby McCoy Research Award UCLA (October 1990)

MEMBERSHIP ON ADVISORY BOARDS

University of California, Los Angeles, National Science Foundation, IGERT, Center for Materials Creation Training Program. Member (2001-2005).

University of Alaska, Fairbanks. Center for Nano-Sensor Technology. Chairman (2001-2005).

FUNDING HISTORY AS PRINCIPAL INVESTIGATOR

Funding Agency	Title	Amount	Performance Period
Defense Advanced Research Projects Agency (DARPA)	Advanced Electroactive Polymer Processing, Characterization, and Device Fabrication for Chemical and Electrochemical Actuation	$5,657,879	4/1998 – 2/2002
DARPA	Thin-Film Analogue Image Processor (TAIP)	$656,139	11/2000 – 9/2002
DARPA	Mobile Water Recovery Using Conducting Polymer Membranes and Adsorbents	$1,752,264	7/2002 – 12/2003
Office of Naval Research (ONR)	Expeditionary Unit Water Purifier Program: Mobile Water Recovery Using Highly Efficient Hollow Fiber	$196,791	10/2004-9/2004

Funding Agency	Title	Amount	Performance Period
	RO Membranes		
ONR	Mobile Water Recovery Using Highly Efficient Hollow Fiber RO Membranes	$450,570	10/2004 - 9/2005
ONR	Expeditionary Warfare Water Purification Program: Water Recovery Using High Efficiency, Conducting Polymer Hollow Fiber Membranes	$147,510	1/2004 - 10/2004
ONR	Expeditionary Warfare Water Purification Program: Water Recovery Using High Efficiency, Conducting Polymer Hollow Fiber Membranes	$762,470	11/2004 - 10/2007
Department of Energy (DOE)	Energy Efficient Electrochromic Windows Incorporating Tonic Liquids	$100,000	2/2005 - 1/2006
NASA	Phase I SBIR: Composite Conducting Polymer Cathodes for High-Energy Density Lithium-Ion Batteries	$125,000	1/2007
NASA	Phase I SBIR: High Recovery, Low Fouling Reverse Osmosis Membrane Elements for Space Wastewater Reclamation	$125,000	
NASA	Phase II SBIR: High Recovery, Low Fouling Reverse Osmosis Membrane Elements for Space Wastewater Reclamation	$700,000	
STATKRAFT (Norway)	High Flux Composite Hollow Fiber Membrane Modules for Pressure Retarded Osmosis of Sea and River Water for Power Generation	$626,853	
STATKRAFT	High Flux Composite Hollow Fiber Membrane Modules for Pressure Retarded Osmosis of Sea and River Water for Power Generation	$585,000	
University of Texas, Dallas (DOE subcontract)	Integrated Water Gas Shift Membrane Reactors Utilizing Novel, Non-precious Metal Mixed Matrix Membranes	$180,000	

PUBLICATIONS

1. *A qualitative and quantitative phytochemical analysis of P. balsamifera in relationship to mammalian herbivory*. BR Mattes.Master of Science Dissertation, Natural Products Chemistry. University of Alaska, Fairbanks, (1986)

2. B.R. Mattes, T.P. Clausen and P.B. Reichardt. *Volatile Constituents of Balsam Poplar: The Phenol Glycoside Connection*. Phytochemistry. 26:1361-1366. (1987).

3. *Third-order nonlinear optical effects in polyaniline doped silica films via the sol-gel technique*," E.T. Knobbe, B. Dunn, P.D. Fuqua, F. Nishida, R.B. Kaner and B.M. Pierce, Ceram. Trans., 14, 137-150 (1990).

4. F. Nishida, B. Dunn, E.T. Knobbe, P.D. Fuqua, R.B. Kaner and B.R. Mattes, *"Incorporation of polyaniline into a silica gel via the sol-gel technique."* Mat. Res. Soc. Symp. Proc., 180, 747-752 (1990).

5. *The Winter Chemical Defense of Alaskan Balsam Poplar Against Snowshoe Hares*. Journal of Chemical Ecology. P.B. Reichardt, J.P. Bryant, B.R. Mattes, T.P. Clausen, F.S. Chapin III, and M. Meyer*, 16:1941-1960 (1990).

6. *Gas separation membranes from conjugated polymer films*. BR Mattes, MR Anderson, H Reiss, RB Kaner. Polym. Mat. Sci. and Eng 64, 336-337 (1991).

7. *Gas separation membranes: A novel application for conducting polymers*. M. R. Anderson, B.R. Mattes, H. Reiss and R.B. Kaner,." Synth. Met., 41, 1151-1154 (1991).

8. *Conjugated polymer films for gas separations. M. R. Anderson, B.R. Mattes*, H. Reiss and R.B. Kaner, **Science**, 252, 1412-1415 (1991).

9. *Polyaniline sol-gels and their third-order nonlinear optical properties*B.R. Mattes, E.T. Knobbe, P.D. Fuqua, F. Nishida, E.-W. Chang, B.M. Pierce, B. Dunn and R.B. Kaner., Synth. Met., 43, 3183-3192 (1991).

10. P.B. Reichardt, F.S. Chapin, III, J.P. Bryant, B.R. Mattes, and T.P. Clausen, Carbon/Nutrient Balance Does Not Fully Explain Patterns of Plant Defense in Alaskan Balsam Poplar. Oecologia 88:401-406. (1991).

11. *Fundamental and applied studies of polyaniline: gas separations, Donnan phenomena, and non-linear optics*. BR Mattes, Doctoral Dissertation, Chemistry. University of California, Los Angeles, (1992).

12. S.J. Kramer, M.W. Colby, J.D. MacKenzie, B.R. Mattes and R.B. Kaner, "Polyaniline-ormasil nanocomposites," in Chemical Processing of Advanced Materials, L.L. Hench and J.K. West, eds. (John Wiley & Sons, New York) pp. 737-744, (1992).

13. *Donnan phenomena in the proton doping of emeraldine*. P Chartier, B Mattes, H Reiss, The Journal of Physical Chemistry 96 (8), 3556-3560 (1992).

14. *Measurement of the charge in a double layer at a solid/liquid interface: use of a conducting polymer*. P Chartier, B Mattes, H Reiss. The Journal of Physical Chemistry 96 (13), 5501-5505 (1992).

15. B.R. Mattes, M.R. Anderson, J.A. Conklin, H. Reiss and R.B. Kaner, *"Morphological modification of polyaniline films for the separation of gases,"* Synth. Met., 57, 3655-3660 (1993).

16. B.R. Mattes, M.R. Anderson, H. Reiss and R.B. Kaner, *"The separation of gases using conducting polymer films," in Intrinsically Conducting Polymers: An Emerging Technology,* M. Aldissi, ed., (Kluwer Academic Publishers, Dordrecht, Netherlands, pp. 61-74 (1993).

17. *Intrinsically conducting polymers: an emerging technology: The Separation of Gases Using Conducting Polymer Films.* BR Mattes, MR Anderson, H Reiss, RB Kaner. Springer 246 (246), 61-74 (1993).

18. *Fullerenes and photonics.* DW McBranch, BR Mattes, A Koskelo, JM Robinson, SP Love. SPIE 2284, 15 (1994).

19. *The synthesis and optical characterization of fullerene glasses.* BR Mattes, D McBranch, A Koskelo, JM Robinson, SP Love. ABSTRACTS OF PAPERS OF THE AMERICAN CHEMICAL SOCIETY 208, 160-PHYS (1994).

20. *C60-doped silicon dioxide sonogels for optical limiting.* DW McBranch, BR Mattes, AC Koskelo, JM Robinson, SP Love. SPIE's 1994 International Symposium on Optics, Imaging, and Instrumentation. (1994).

21. *Processing-induced changes in the local structure of amorphous polyaniline by radial distribution function analysis of X-ray scattering data.* J Maron, MJ Winokur, BR Mattes. Macromolecules 28 (13), 4475-4486 (1995).

22. *Optical limiting and excited-state absorption in fullerene solutions and doped glasses.* Duncan W McBranch, Laura B Smilowitz, Victor I Klimov, Aaron C Koskelo, Jeanne M Robinson, Benjamin R Mattes, Jan C Hummelen, Fred Wudl, James C Withers, Nicholas F Borrelli. SPIE's 1995 International Symposium on Optical Science, Engineering, and Instrumentation. 196-204 (1995).

23. J.A. Conklin, M.R. Anderson, H. Reiss and R.B. Kaner, *"Anhydrous halogen acid interaction with polyaniline membranes: A gas permeability study,"* J. Phys. Chem., 100, 8425-8429 (1996).

24. *Dual mechanism of equilibrium sorption in polymer systems: A generalized theory.* AV Seregin, VI BondaR, BR Mattes, YP Yampol'skii, VV Volkov. Polymer science. Series B 38 (3-4), 165-173

25. *Femtosecond to nanosecond dynamics in C- 60: Implications for excited-state nonlinearities.* D McBranch, V Klimov, L Smilowitz, JM Robinson, A Koskelo, M Grigorova, BR Mattes. TECHNICAL DIGEST SERIES-OPTICAL SOCIETY OF AMERICA 11, 38-40 (1996).

26. *Femtosecond to nanosecond dynamics of c <>: implications for excited-state nonlinearities.* V Klimov, D McBranch, L Smilowitz, J Robinson, BR Mattes, A Koskelo. Res. Chem. Intermed., special, 587-600 (1996).

27. *Femtosecond nondegenerate four-wave mixing C- 6- o/polymer blends.* E Maniloff, D McBranch, B Mattes. TECHNICAL DIGEST SERIES-OPTICAL SOCIETY OF AMERICA 11, 400-402 (1996).

28. *Transport and other physicochemical properties of polyaniline.* BR Mattes. Proceedings of the 8th Annual Meeeting of the North American Membrane Society. (1996).

29. *A CP/MAS NMR Characterization of the structure and dynamics of HF doped polyaniline.* MP Espe, J Schaefer, BR Mattes. APS March Meeting Abstracts 1, 3179 (1996).

30. *Optical limiting and excited-state absorption in fullerene derivatives.* LB Smilowitz, DW McBranch, VI Klimov, AC Koskelo, JM Robinson, BR Mattes, JC Hummelen, F Wudl. Laser-Induced Damage in Optical Materials: 1995, 31-32 (1996).

31. *Enhanced optical limiting in derivatized fullerenes.* L Smilowitz, H Wang, F Wudl, D McBranch, V Klimov, JM Robinson, A Koskelo, M Grigorova, BR Mattes. Optics letters 21 (13), 922-924 (1996).

32. *Gas sorption in polyaniline. 1. Emeraldine base.* J Pellegrino, R Radebaugh, BR Mattes. Macromolecules 29 (14), 4985-4991 (1996).

33. *Femtosecond electron-transfer holography in C [sub 60]/polymer blends.* E Maniloff, D Vacar, D McBranch, HL Wang, B Mattes, AJ Heeger. Los Alamos National Lab., NM (United States) LA-UR--96-3199; CONF-960784-9, (1996).

34. *Enhanced optical limiting behavior of fullerene derivatives.* A Koskelo, L Smilowitz, D McBranch, V Klimov. American Chemical Society, Washington, DC, (1996).

35. *Determination of the local molecular structure in amorphous polyaniline.* MJ Winokur, BR Mattes. Physical Review B 54 (18), R12637 (1996).

36. *Femtosecond excited-state absorption dynamics and optical limiting in fullerene solutions, sol-gel glasses, and thin films.* DW McBranch, VI Klimov, LB Smilowitz, M Grigorova, JM Robinson, Aaron C Koskelo, Benjamin R Mattes, H Wang, Fred Wudl. SPIE's 1996 International Symposium on Optical Science, Engineering, and Instrumentation. 140-150 (1996).

37. *Charge-transfer polymers: a new class of materials for nonlinear optics.* ES Maniloff, DW McBranch, HL Wang, BR Mattes, D Vacar, AJ Heeger. SPIE's International Symposium on Optical Science, Engineering, and Instrumentation. 208-213, (1996).

38. *Optical limiting processes in derivatized fullerenes and porphyrins/phthalocyanines.* R Kohlman, V Klimov, X Shi, M Grigorova, BR Mattes, D McBranch, H Wang, F Wudl, J-L Nogues, W Moreshead. MRS Proceedings 488, 237 (1997).

39. *Formation of conductive polyaniline fibers derived from highly concentrated emeraldine base solutions.* BR Mattes, HL Wang, D Yang, YT Zhua, WR Blumenthala, MF Hundley. Synthetic Metals 84 (1), 45-49 (1997).

40. *Fullerene doped glasses as solid state optical limiters.* L Smilowitz, D McBranch, V Klimov, M Grigorova, JM Robinson, BJ Weyer, A Koskelo, BR Mattes, H Wang, F Wudl. Synthetic Metals 84 (1), 931-932 (1997).

41. *Variations in the optical properties of poly (3-hexylthiophene)/C 60 blends and poly (3-hexylthiophene)/sol-gel composites.* HL Wang, M Grigorova, ES Maniloff, DW McBranch, BR Mattes Synthetic Metals 84 (1), 781-782 (1997).

42. *Differential anomalous scattering studies of amorphous HBr-doped polyaniline.* MJ Winokur, BR Mattes. Synthetic Metals 84 (1), 725-728 (1997).

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44. *Femtosecond to nanosecond dynamics in fullerenes: Implications for excited-state optical nonlinearities.* V Klimov, L Smilowitz, H Wang, M Grigorova, JM Robinson, A Koskelo, BR Mattes, F Wudl, DW McBranch. Research on chemical intermediates 23 (7), 587-600 (1997).

45. *Ultrafast holography using charge-transfer polymers.* ES Maniloff, D Vacar, DW McBranch, HL Wang, BR Mattes, J Gao, Alan J Heeger. Optics communications 141 (5), 243-246 (1997).

46. *Packing in Amorphous Regions of Hydrofluoric-Acid-Doped Polyaniline Powder by 15N-19F REDOR NMR.* MP Espe, BR Mattes, J Schaefer. Macromolecules 30 (20), 6307-6312 (1997).

47. *Ultrafast and nonlinear optical characterization of optical limiting processes in fullerenes.* RS Kohlman, VI Klimov, M Grigorova, X Shi, BR Mattes, DW McBranch, H Wang, Fred Wudl, Jean-Luc R Nogues, William V Moreshead. Optical Science, Engineering and Instrumentation'97, 72-82 (1997).

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49. *Characterization of Anisotropic Polyaniline Films.* R Ou, T Liu, R Samuels, H Wang, B Mattes, S Hardaker, L Ding, R. Gregory. TECHNICAL PAPERS OF THE ANNUAL TECHNICAL CONFERENCE-SOCIETY OF PLASTICS, 351-1354 (1998).

50. *New fullerene-based mixed materials: Synthesis and characterization.* D McBranch, R Kohlman, V Klimov, M Grigorova, X Shi, L Smilowitz BR Mattes, H Wang, F Wudl. Los Alamos National Lab., NM (US) LA-UR--98-1832, (1998).

51. *Structural studies of halogen acid doped polyaniline and the role of water hydration.* MJ Winokur, BR Mattes. Macromolecules 31 (23), 8183-8191 (1998).

52. *Rheokinetic analysis of highly concentrated, high molecular weight emeraldine base (EB) solutions.* BR Mattes, D Yang. ABSTRACTS OF PAPERS OF THE AMERICAN CHEMICAL SOCIETY 217, U444-U444 (1999).

53. *Investigation of gel inhibitor assisted dissolution of polyaniline: A case study for emeraldine base, 2-methyl-aziridine, and N-methyl-pyrrolidone.* D Yang, BR Mattes. Synthetic metals 101 (1), 746-749 (1999).

54. *Gas transport and sorption in polyaniline thin film.* HL Wang, BR Mattes. Synthetic metals 102 (1), 1333-1334 (1999).

55. *Polyaniline as viewed from a structural perspective.* MJ Winokur, BR Mattes. CONDUCTIVE POLYMERS, 11 (1999).

56. *Electrically conductive polyaniline fibers prepared by dry-wet spinning techniques.* BR Mattes, HL Wang, D Yang. CONDUCTIVE POLYMERS, 135 (1999).

57. *Fabrication and Characterization of Conductive Polyaniline Fiber.* HL Wang, BR Mattes, Y Zhu, JA Valdez. CONDUCTIVE POLYMERS, 127 (1999).

58. Conductive Polymers and Plastics: In Industrial Applications. B.R. Mattes, L Rupprecht, William Andrew, (1999).

59. *Effect of processing conditions on the properties of high molecular weight conductive polyaniline fiber.* HL Wang, RJ Romero, BR Mattes, Y Zhu, MJ Winokur. Journal of Polymer Science Part B: Polymer Physics 38 (1), 194-204 (2000).

60. *Solution-processing influences on polyaniline films characterized by solid-state NMR.* T.L. Young, D Yang, B.R. Mattes, M.P. Espe. ABSTRACTS OF PAPERS OF THE AMERICAN CHEMICAL SOCIETY 219, U484-U484 (2000).

61. *Rheokinetic study of concentrated high molecular weight emeraldine base in N-methyl-2-pyrrolidinone solutions containing 2-methyl-aziridine.* D. Yang, B Mattes. Molecular Crystals and Liquid Crystals 353 (1), 341-354

62. *Intrinsic viscosity measurement of dilute emeraldine base solutions for estimating the weight average molecular weight of polyaniline.* D. Yang, P.N. Adams, B.R. Mattes. Synthetic metals 119 (1-3), 301-302 (2001).

63. *Rheokinetic Study of Concentrated High Molecular Weight Emeraldine Base in N-Methyl-2-Pyrrolidinone Solutions Containing Secondary Amines,* D. Yang, B.R. Mattes. Molecular Crystals and Liquid Crystals 353, 341-354 (2001).

64. *Controlling macrovoid formation in wet-spun polyaniline fibers.* D Yang, A Fadeev, PN Adams, BR Mattes. SPIE's 8th Annual International Symposium on Smart Structures and Materials., 59-71, (2001).

65. *Electrochemical actuation of gilded polyaniline bilayers in aqueous acid solutions.* W. Lu, E. Smela, B.R. Mattes. SPIE's 8th Annual International Symposium on Smart Structures and Materials . 505-515, (2001).

66. *Molecular weight dependence of the physical properties of protonated polyaniline films and fibers.* PN Adams, D Bowman, L Brown, D Yang, BR Mattes. SPIE's 8th Annual International Symposium on Smart Structures and Materials . 475-481, (2001).

67. *Use of Ionic Liquids for π-Conjugated Polymer Electrochemical Devices.* W. Lu, A.G. Fadeev, B.H. Qi, E. Smela, B.R. Mattes (corresponding author), Ding, G.M. Spinks, J. Mazurkiewicz, D.Z. Zhou, G.G. Wallace, DR MacFarlane, SA Forsyth, M. Forsyth. **Science** 297, 983 (2002).

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71. *Electroactive polyacrylonitrile nanofibers as artificial nanomuscles.* M Shahinpoor, ID Norris, BR Mattes, KJ Kim, LO Sillerud. SPIE's 9th Annual International Symposium on Smart Structures and Materials ..(2002).

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73. *Effect of elevated temperature on the reactivity and structure of polyaniline.* R Mathew, D Yang, BR Mattes, MP Espe. Macromolecules 35 (20), 7575-7581 (2002).

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75. *A solid state NMR characterization of cross-linked polyaniline powder.* R. Mathew, B.R. Mattes, M.P. Espe. Synthetic Metals 131 (1), 141-147 (2002).

76. *Polyaniline emeraldine base in N-methyl-2-pyrrolidinone containing secondary amine additives: A rheological investigation of solutions.* D Yang, BR Mattes. Journal of Polymer Science Part B: Polymer Physics 40 (23), 2702-2713 (2003).

77. *Stable conducting polymer electrochemical devices incorporating ionic liquids.* W Lu, AG Fadeev, B Qi, BR Mattes. Synthetic metals 135, 139-140 (2003)

78. *New methods for determining the molecular weight of polyaniline by size exclusion chromatography.* D Yang, PN Adams, R Goering, BR Mattes. Synthetic metals 135, 293-294 (2003).

79. *Electrochemical behavior and electromechanical actuation of PANI in nonaqueous electrolytes.* W. Lu, B.R. Mattes. Journal of The Electrochemical Society 150 (9), E416-E422 (2003).

80. Special Issue: Proceedings of the International Conference on Science and Technology of Synthetic Metals, Wollongong, Australia, June 28–July 2, 2004, Part III. M Trchová, I Šeděnková, J Stejskal, T Canteenwala, PA Padmawar, S Patil, M Haldar, LY Chiang, L Thomsen, B Watts, DV Cotton, PC Dastoor, Y Matsuo, K Sugita, S Ikehata, P He, S Li, L Dai, SM Chang, HW Liao, CL Lin, JT Lee, S Brady, KT Lau, W Megill, GG Wallace, D Diamond, D Bowman, BR Mattes, D Aussawasathien, JH Dong, L Dai, K Inoue, R Ulbricht, PC Madakasira, WM Sampson, S Lee, J Gutierrez, J Ferraris, AA Zakhidov, K Marumoto, Y Muramatsu, S Ukai, H Ito, S Kuroda, SW Hur, HS Oh, YC Oh, DH Chung, JU Lee, JW Park, TW Kim. (2004).

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85. *Strain and energy efficiency of polyaniline fiber electrochemical actuators in aqueous electrolytes.* B Qi, W Lu, BR Mattes. The Journal of Physical Chemistry B 108 (20), 6222-6227 (2004).

86. *Electropolymerization of polyaniline from ionic liquids.* A. Saheb, M. Josowicz, J. Janata, B.R. Mattes. Electrode Processes VII: Proceedings of the International Symposium, 192 (2004).

87. *Electrochemical actuator devices based on polyaniline yarns and ionic liquid electrolytes.* W. Lu, I.D. Norris, B.R. Mattes. Australian Journal of Chemistry 58 (4), 263-269 (2005).

88. *Polyaniline actuators: Part 1. PANI (AMPS) in HCl.* E Smela, W Lu, B.R. Mattes. Synthetic Metals 151 (1), 25-42 (2005).

89. *Polyaniline actuators: Part 2. PANI (AMPS) in methanesulfonic acid.* E. Smela, B.R. Mattes. Synthetic metals 151 (1), 43-48 (2005)

90. *Factors influencing electrochemical actuation of polyaniline fibers in ionic liquids.* W. Lu, B.R. Mattes, Synthetic Metals, 152 (1), 53-56 (2005).

91. *Development of integrally skinned asymmetric polyaniline hollow fibers for membrane applications.* I.D. Norris, A.G. Fadeev, J. Pellegrino, B.R. Mattes. Synthetic metals 153 (1), 57-60 (2005).

92. *Conductive fibre prepared from ultra-high molecular weight polyaniline for smart fabric and interactive textile applications.* D. Bowman, B.R. Mattes. Synthetic metals 154 (1), 29-32 (2005).

93. *Water sorption of acid-doped polyaniline solid fibers: equilibrium and kinetic response.* M.M. Ostwal, J. Pellegrino, I. D. Norris, T.T. Tsotsis, M. Sahimi, B.R. Mattes. Industrial & engineering chemistry research 44 (20), 7860-7867 (2005).

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96. *Conjugated polymers: processing and applications; Conducting Polymer Fiber Production and Applications.* I.D. Norris, B.R. Mattes. CRC 2, 2-1-2-63 (2006)

97. *Water sorption of acid-doped polyaniline powders and hollow fibers: equilibrium and kinetic response.* M.M. Ostwal, B. Qi, J. Pellegrino, A.G. Fadeev, I.D. Norris, T.T. Tsotsis, M. Sahimi, ... Industrial & engineering chemistry research 45 (17), 6021-6031 (2006).

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69. *Conducting polymer fiber production and applications.* J.D. Norris, B.R. Mattes. Handbook of Conducting Polymers. New York: CRC Press, 3rd ed., Marcel Dekker, Chapter 2 (2007).

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101. *Investigation of interaction among polyaniline, organic acid, and water.* D. Yang, B.R. Mattes Synthetic Metals 158 (16), 654-660 (2008).

102. *Substituted polyaniline nanofibers produced via rapid initiated polymerization.* HD Tran, J Norris, JM D'Arcy, H Tsang, Y Wang, BR Mattes, RB Kaner, Macromolecules 41 (20), 7405-7410 (2008)

103. *Kinetic hysteresis in gas adsorption behavior for a rigid MOF arising from zig-zag channel structures.* Q Wei, D Yang, TE Larson, TL Kinnibrugh, R Zou, NJ Henson, Journal of Materials Chemistry 22 (20), 10166-10171 (2012)

PATENTS

1) Benjamin R Mattes, Andrei G Fadeev: *Long-lived conjugated polymer electrochemical devices incorporating ionic liquids.* Santa Fe Science and Technology Dec, 7 2004: US 6828062 (22 citation)

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5) Duncan W McBranch, Benjamin R Mattes, Aaron C Koskelo, Alan J Heeger, Jeanne M Robinson, Laura B Smilowitz, Victor I Klimov, Myoungsik Cha, N Serdar Sariciftci, Jan C Hummelen: *Optical limiting materials.* University of California Apr, 21 1998: US 5741442 (5 citation)

6) Elisabeth Smela, Benjamin R Mattes, Philip N Adams, Guido Zuccarello, Wen Lu: *Electrochemical devices incorporating high-conductivity conjugated polymers.* Aug, 3 2006: US 20060169954 (4 citation)

7) Hsing-Lin Wang, Benjamin R Mattes: *Permeable polyaniline articles for gas separation.* University of California Sep, 28 2004: US 6797325 (3 citation)

8) Elisabeth Smela, Mark W Tilden, Benjamin R Mattes: *Conjugated polymer actuator responsive to electrical stimulation.* Santa Fe Science and Technology Aug, 30 2005: US 6936955 (2 citation)

9) Baohua Qi, Benjamin R Mattes: *Multifunctional conducting polymer structures.* Mar, 23 2005: US 20050062486 (2 citation)

11) Baohua Qi, Benjamin R Mattes: *Multifunctional conducting polymer structures.* Santa Fe Science and Technology May, 21 2009: US 20090128168 (1 citation)

12) Baohua Qi, Benjamin R Mattes: *Multifunctional conducting polymer structures.* Santa Fe Science and Technology Dec, 9 2008: US 7463040 (1 citation)

13) Benjamin R Mattes, Russell M Goering, Phillip N Adams, Guido Zuccarello: *Synthesis Of Polyaniline.* Santa Fe Science And Technology Oct, 25 2007: US 20070249803 (1 citation)

14) Wen Lu, Benjamin R Mattes, Andrei G Fadeev, Baohua Qi: *Stable conjugated polymer electrochromic devices incorporating ionic liquids.* Dec, 19 2002: US 20020191270 (1 citation)

15) Hsing-Lin Wang, Benjamin R Mattes: *Stable, concentrated solutions of polyaniline using amines as gel inhibitors.* University of California Aug, 6 2002: US 6429282 (1 citation)

17) Benjamin R Mattes, Hsing-Lin Wang: *Stable, concentrated solutions of high molecular weight polyaniline andarticles therefrom.* University of California Nov, 9 1999: US 5981695

18) Benjamin R Mattes, Phillip N Adams, Dali Yang, Lori A Brown, Andrei G Fadeev, Ian D Norris: *Spinning, doping, dedoping and redoping polyaniline fiber.* Santa Fe Science And Technology Nov, 3 2011: US 20110266503

19) Benjamin R Mattes, Phillip N Adams, Dali Yang, Lori A Brown, Andrei G Fadeev, Ian D Norris: *Spinning, doping, dedoping and redoping polyaniline fiber.* Santa Fe Science and Technology Mar, 25 2010: US 20100072428

20) Baohua Qi, Benjamin R Mattes: *Multifunctional conducting polymer structures.* Santa Fe Science and Technology Mar, 23 2010: US 7683643

21) Benjamin R Mattes, Phillip N Adams, Dali Yang, Lori A Brown, Andrei G Fadeev, Ian D Norris: *Spinning, doping, dedoping and redoping polyaniline fiber.* Santa Fe Science and Technology Dec, 8 2009: US 7628944

22) Hsing-Lin Wang, Benjamin R Mattes: *Permeable polyaniline articles for gas separation.* Los Alamos National Security Jul, 21 2009: US 7563484

23) Wen Lu, Elisabeth Smela, Phillip N Adams, Guido Zuccarello, Benjamin R Mattes: *Solid-in-hollow polymer fiber electrochemical devices.* Santa Fe Science and Technology Oct, 30 2007: US 7288871.

24) Baohua Qi, Benjamin R Mattes: *Resistive heating using polyaniline fiber.* Sante Fe Science and Technology Nov, 7 2006: US 7132630

25) Hsing-Lin Wang, Benjamin R Mattes: *Permeable polyaniline articles for gas separation.* Feb, 17 2005: US 20050037149

26) Baohua Qi, Benjamin R Mattes: *Resistive heating using polyaniline fiber. Jul, 29 2004:* US 20040144772

27) Benjamin R Mattes, Phillip N Adams, Dali Yang, Lori A Brown, Andrei G Fadeev, Ian D Norris: *Spinning, doping, dedoping and redoping polyaniline fiber.* Jun, 24 2004: US 20040119187.

28) Hsing-Lin Wang, Benjamin R Mattes: *Permeable polyaniline articles for gas separation.* Aug, 28 2003: US 20030162939.

29) Benjamin R Mattes, Hsing-Lin Wang: *Method for preparing polyaniline fibers*. University of California Sep, 26 2000: US 6,123,883.

30) Benjamin R Mattes, Hsing-Lin Wang: *Stable, concentrated solutions of high molecular weight polyaniline and articles therefrom*. University of California Aug, 8 2000: US 6,099,907

INVITED SEMINARS AND PAPERS (Through 2004)

1. "The Non-linear Optical Effects of Polyaniline Sol-gel Composites." Symposium on Non-Linear Optics. The American Chemical Society Meeting, NLO Symposium, Boston, MA. April (1990)

2. "Polyaniline Films for Gas Separations." The 1990 UCLA Herbert Newby McCoy Award Lecture. University of California, Los Angeles, CA. May (1991)

3. "Industrial Potential for Conducting Polymers in the Markets of Gas Separation." TNO Plastics and Rubber Research Institute, TNO, Delft, The Netherlands. August (1991) Sponsor: Dr. A.P.M. Van der Veek.

4. "Conjugated Polymers for Gas Separations and Non-linear Optics." University of Montpelier, Montpelier, France. December (1991) Host: Prof. Patrick Bernier.

5. "Incorporation of Conjugated polymers in a SiO_2 Matrix for NLO studies." Science Center, Rockwell International, Thousand Oaks, CA. June (1992) Hosts: Drs. Mark Rosker and Henry Marcy.

6. "Buckministerfullerene Sol-gel Composites for NLO applications." Science Center, Hughes Aircraft Co., Malibu, CA. June (1992) Host: Dr. Marvin Klein.

7. "Materials Science Approach to Understanding Gas Permeability Phenomena in Polyaniline Membranes." National Institute of Standards and Technology, Boulder, CO. September (1992) Host: Dr. John Pellegrino.

8. "A Materials Science Case Study of New Polymeric Materials for Gas Separations: Correlation of Physical and Morphological Characteristics of Conducting Polymers with Pure Gas Permeabilities." Advances in Filtration and Separation Technology, AES Meeting, Chicago, IL. May 3-5 (1993)

9. "Morphological Properties of Polyaniline Membranes Responsible for Gas Separations". Gordon Conference: Ultrafiltration, Reverse Osmosis and Gas Separation, Plymouth College, NH. July (1993)

10. "Conducting Polymers for Gas Separations". International Congress on Membranes. Heidelberg, Germany. August 29-September 3 (1993) Chairmen: Profs. William Koros and Yuri Yamploski.

11. "The Physical Chemistry of Gas Separations Through Polymer Membranes." Uniax Corporation. Santa Barbara, CA. October 23 (1993) Host: Prof. Alan Heeger.

12. "Advanced Analytical Equipment for Measuring Gas Permeabilities." A.V. Topchiev Institute of Petrochemical Synthesis, Moscow, Russia. September 15 (1994) Host: Prof. Nicolai Plate.

13. "Opportunities for Joint Technical Collaborations Between Russia and the USA in the Field of Gas Separations." Kurchatov Institute, Moscow, Russia. September 22 (1994) Host: Euginy Krashninnikov.

14. "The Physical Chemistry of Membrane Based Separations." University of Wisconsin, Madison, Chemistry Departmental Seminar. October 26 (1994) Host: Prof. Michael Winokur.

15. "Some Recent Advances in Fullerene and Conducting Polymer Research." LANL, T-12 Group Seminar. May 1 (1995) Hosts: Alan Bishop and Niels Jensen.

16. "Commencement Day Address to the Graduating Class of Chemists." Moscow State University, Moscow, Russia. May 13 (1995) Host: Dean Valery Lunin, Department of Chemistry.

17. "Optical Limiting Behavior in Fullerene Aerogel Composites." MacDonald Douglas, St. Louis, MO. August 23 (1995) Host: Bruce Shawgo.

18. "Transport Properties of Conducting Polymers," Washington University, Department of Chemistry, St. Louis, MO. August 24 (1995) Host: Prof. Jacob Schaefer.

19. "Structural Correlation of Conductive Polymer Films with Charge and Mass Transport Behavior." Monsanto Company, St. Louis, MO. August 25 (1995) Hosts: Drs. Phillip Brodsky and Patrick Kinlen.

20. "Synthetic Routes to Polyanilines." Chemical Science and Technology Division Chemical Synthesis Group. September 6 (1995) Hosts: Pete Silks and Cliff Unkefer.

21. "Gas Transport through Polyaniline and Polytrimethylsilylpropyne Membranes." Inorganic Chemistry Departmental Chemistry Seminar, University of California, Los Angeles, CA. October 4 (1995) Hosts: Professors Richard Kaner and Robin Garrell.

22. "Material Properties of Barrier materials." Hughes Research Center, Malibu, CA, October 6 (1995) Host: Dr. Marvin Klein.

23. "Transport and Membrane Formation Properties of Polyaniline," AIChE Spring Meeting, New Orleans, LA. February 25-29 (1996) Session Chairs: Dr. Benny Freeman and Mary Rezac.

24. "Synthesis and Applications of Conducting Polymers Configured as Films, Coatings and Fibers." PPG Industries, Inc., Pittsburgh, PA. March 13 (1996) Host: Jerry Gruber, Vice-President Resins and Coatings Division.

25. "Fullerene Glasses: Optical Limiting and Photochromism." PPG Industries, Inc., Pittsburgh, PA. March 13 (1996) Host: David McKeough, Director of Chemicals.

26. "Transport and Other Physio-Chemical Properties of Polyaniline." North American Membrane Society Meeting, Ottawa, Canada. May 20 (1996) Co-Chairs: D. Loyd and M. Guiver.

27. "Strategies for Improving Polytrimethylsilylpropyne (PTMSP) for Gas Separation Applications." North American Membrane Society Meeting, Ottawa, Canada. May 21 (1996) Co-Chairs D. Loyd and M. Guiver.

28. "The Development of Polyaniline Membranes for Chemical Separations." International Conference of Synthetic Metals, Snowbird, Utah. July 30 (1996)

29. "Conducting Polymer Membranes for Chemical Separations." 36th IUPAC International Symposium on Macromolecules, Seoul, Korea. August 5 (1996)

30. "Gas Separations with Integrally Skinned Asymmetric Polyaniline Membranes." Samsung Corporation, Korea. August 13 (1996) Host: Dr. Shinee Kang.

31. "Formation Parameters for Integrally Skinned Polyaniline Hollow Fibers." Korean Institute of Science and Technology, Seoul, Korea, August 12 (1996) Host: Dr. Yong Soo Kang.

32. "Some Recent Advances in Solution Processing of Polyaniline." So Gang University, Seoul, Korea. August 15 (1996) Hosts: Profs. Li and Rhee.

33. "Optical Limiting and Reverse Saturable Absorbance in Fullerene Glasses." Materials Science Departmental Seminar, University of California, Los Angeles, CA. October 4 (1996) Host: Professor Bruce Dunn.

34. "Conducting Polymer Membranes for Chemical Separations." 36th IUPAC International Symposium on Macromolecules, Seoul, Korea. August 5 (1996)

35. "Formation Parameters for Integrally Skinned Polyaniline Hollow Fibers." Korean Institute of Science and Technology, Seoul, Korea. August 12 (1996) Host: Dr. Yong Soo Kang.

36. "Gas Separations with Integrally Skinned Asymmetric Polyaniline Membranes." Samsung Corporation, August 13 (1996) Host: Dr. Shinee Kang.

37. "Some Recent Advances in Solution Processing of Polyaniline." So Gang University, Seoul, Korea. August 15 (1996) Hosts: Profs. Li and Rhee.

38. "Advances in Solid State Optical Liming Devices." Department Seminar, Department of Materials Science, University of California, Los Angeles, CA. October 1 (1997) Host: B. Dunn.

39. "Recent Strategies for Synthesizing Fullerene Based Optical Limiting Devices." Department Seminar, Department of Chemistry and Biochemistry, University of California, Los Angeles, CA. November 18 (1997) Host: H. Kaez.

40. "The Development of High Strength Electrically Conducting Fibers with High Conductivity." International Symposium on the Technology of Inherently Conducting Polymers, San Diego, CA. March 3-5 (1997) Chair: M. Aldissi.

41. "Electrically Conductive Polyaniline Fibers Prepared by Dry-Wet Spinning Techniques." Antech '97: Society of Plastics Engineers, Toronto, Canada. April 27-May 1 (1997) Chair: A.J. Mac Diarmid.

42. "New Solution Processing Routes to Thin Films of Conducting Polymers and Their Applications." Gordon Conference on Thin Films and Coatings, NH. July 14-17 (1997) Chair: D. Boyd.

43. "Temperature and Pressure Dependant Gas Transport Through Polyaniline Membranes." 13th International Symposium on Thermophysical Properties, Boulder, CO. June 16-19 (1997) Chairperson: John Pelligrino.

44. "New Solution Processing Routes to Thin Films of Conducting Polymers and Their Applications." Gordon Conference on Thin Films and Coatings. July 14-17, 1997. Chairperson: D. Boyd. New London, New Hampshire.

45. "Gas Sensing Properties of Polyaniline Membranes." Hughes Research Labs. October 18-19, 1998. Host: Fred Yamagishi. Malibu, California.

46. "Technical Aspects of Modified Ballistic Missile Rocket Engine Systems for the Destruction of Super-Toxic Chemicals." The Potomac Foundation, Washington, D.C. January (1998) Hosts: Dan MacDonald and Phil Petersen.

47. "Asymmetric PTMSP Hollow Fiber Membranes for Oxygen Enrichment." Permea/Air Products, St. Louis, MO. January 27 (1998) Hosts: John Tao and Pushpinder Puri.

48. "Formation of Conductive Polyaniline Fibers Derived from Highly Concentrated Emeraldine Base Solutions." International Conference of Synthetic Metals, Snowbird, Utah. (1998) Chair: A. G. Mac Diarmid.

49. "Membrane Applications of Advance Polymer Materials." Neste Oy, Helsinki, Finland. February 2 (1998) Host: Matti Jussila.

50. "Solution Processing of Polyaniline Fibers." Neste Oy, Helsinki, Finland. February 3 (1998) Host: Jan-Erik Osterholm.

51. "Defense Conversion in the Former Soviet Union," The Potomac Foundation, Washington D.C. March (1998) Hosts: Joseph Braddock and Phil Petersen.

52. "Recent Advances in Processing Conducting Polymers and Their Applications." Defense Sciences Research Council, Washington, D.C. May 6 (1998) Hosts: Milan Mirsch and Hayden Wadely.

53. "Rheological Properties of Highly Concentrated Polyaniline Solutions." IUPAC Macromolecules Conference, Gold Coast, Australia. July 22-27 (1998) Chairperson: Gordan Wallace.

54. "Applications for Conductive Polymer Fiber." Workshop on Applications of Conducting Polymers, University of Wollongong, Australia. July 18-19 (1998) Chairperson: Gordan Wallace.

55. "Rheokinetic Study of Concentrated High Molecular Weight Emeraldine Base in N-Methyl-2-Pyrrolidinone Solutions Containing 2-Methyl-Aziridine." Proceedings of the 5th International Conference on Frontiers of Polymers and Advanced Materials, College of Textiles Engineering Chairperson, Poznan, Poland. (1999) Host: Paris Prasad.

56. "Advanced Electroactive Polymer Processing, Characterization, and Device Fabrication for Chemical and Electrochemical Mechanical Actuation." DARPA Principal Investigators Meeting, Orlando, FL. January 29 (2002)

57. "Electronic Textiles Based on Homogeneous Polyaniline Fiber." Du Pont Seminar, Wilmington, DE. February 5 (2002) Host: Jim Trainham.

58. "CONDUCTING POLYMER FIBRES FOR ARTIFICIAL MUSCLES." Advanced Materials for Sensors and Actuators: Role of Nanotechnology, University of Wollongong and IPRI, Wollongong, Australia. February 13-15 (2002) Host: Gordan Wallace.

59. "ELECTRO-MECHANICAL ACTUATORS BASED UPON CONDUCTING POLYMER FIBRE AND IONIC LIQUID ELECTROLYTES." 8th International Symposium on Polymer Electrolytes, Santa Fe, NM. May 22 (2002) Host: Tom Zawodzinski.

60. "Electronic Textiles Based on Homogenous Polyaniline Fiber." International Interactive Textiles for the Warrior Conference, Cambridge, MA. July 16 (2002)

61. "Stable Conducting Polymer Electrochemical Devices Incorporating Ionic Liquids." University of Alaska, Fairbanks, Alaska. September 12 (2002) **Host: Kelly Drew.**

62. "Stable Conducting Polymer Electrochemical Devices Incorporating Ionic Liquids." Hughes Research Laboratory, Malibu, CA. November 12 (2002) Host: Fred Yamagichi

63. "Use of Stable Room Temperature Ionic Liquids for -Conjugated Polymer Electrochemical Devices." Merck KGaA / NB-C, N 18, Darmstadt, Germany. Host: Dr. Urs Welz-Biermann.

64. "Advanced Electroactive Polymer Processing, Characterization, and Device Fabrication for Chemical and Electrochemical Mechanical Actuation." ORMECON, Hamburg, Germany. November 20 (2002) Host: Bernhard Wessling.

65. "Nanoscience and Molecular Electronics." Applied Materials, Santa Clara, CA. February 3 (2002) Host: Dr. John Madok.

66. "Conjugated Polymers for Commercial Applications." Canon Corporation, Santa Clara, CA. February 3 (2002) Host: Dr. John Forbis.

67. "Electronic Textiles Based on Homogenous Polyaniline Fiber." International Conference on Science and Technology of Synthetic Metals, Shanghai,Peoples Republic of China. July 5 (2002)

68. "Stable Conducting Polymer Electrochemical Devices Incorporating Ionic Liquids" International Conference on Science and Technology of Synthetic Metals, Shanghai, Peoples Republic of China, July 6 (2002)

69. "Dependence of the Electrical Properties of Polyaniline Film and Fiber Upon Processing Conditions." Intelligent Polymer Research Institute, International Workshop: Electronic Fibers and Textiles, Wollongong Australia. February 7 (2003) Host: Gordan Wallace.

70. "Recent Developments in Conducting Polymer Electrochemical Mechanical Actuators Using Ionic Liquid Electrolyte." Advanced Materials and NanoScience-1, Wellington, New Zealand. February 13 (2003) Session Chair: John Spencer.

71. "ELECTROCHROMIC WINDOW AND DISPLAYS BASED ON CONDUCTING POLYMERS AND ROOM TEMPERTAURE IONIC LIQUIDS." 203rd Meeting of the Electrochemical Society, Paris, France. May 2 (2003)

72. "Actuating and Sensing with Conducting Fiber Systems." Gordan Research Conference on Chemical Sensors and Interfacial Design. Atlantic Beach, RI. August 4 (2003) Session Chair: Art Snow.

73. "Mobile Water Recovery Using Conducting Polymer Membranes and Adsorbents." DARPA-TACOM, Washington D.C. October 28 (2003) Program Manager: Len Buckley.

74. "ELECTRONIC TEXTILES BASED ON PANION FIBRE." Symposium Regarding a New Generation of Wearable Systems for e-Health, Lucca, Tuscany, Italy. December 14 (2003) Host: Danilo DeRossi.

75. "SMART TEXTILES BASED ON NANOSTRUCTURES." NANOSET; a workshop regarding advances in Nano-Science, University of New Mexico, Albuquerque, NM. January 15 (2004)

76. "CONDUCTIVE POLYMER FIBERS FOR MILITARY AND HOMELAND SECURITY APPLICATIONS." Washington D.C. February 20 (2004) Host: Mel Berstein and Dave Edwards.

77. "Electronic Textiles Based on Intrinsically Conducting Polymer Fibre." New Mexico Institute of Mining and Technology, Socorro, NM. March 22 (2004)

78. "Actuating and Sensing with Conducting Fiber Systems." Naval Research Laboratory, Washington D.C. October 27 (2003) Host: Carlos Sanday.

79. "Actuating and Sensing with Conducting Fiber Systems." Office of Naval Research, Washington D.C. October 27 (2003) Host: Paul Armistead.

80. "ELECTRONIC TEXTILES BASED ON INTRINSICALLY CONDUCTING POLYMER FIBRE." TechTextil Symposium, Atlanta, GA. March 31 (2004) Chairman: Maurice Larrivee.

81. "ELECTRONIC TEXTILES BASED ON INTRINSICALLY CONDUCTING POLYMER FIBRE FOR RESISTIVE HEATING APPLICATIONS." Malden Mills Corporation, Malden, MA. April 19 (2004) Host: Gadi Vainer.

82. "ELECTRONIC TEXTILES BASED ON INTRINSICALLY CONDUCTING POLYMER FIBRE FOR MECHANICAL ACTUATION." Mide Corporation, Boston, MA. April 20 (2004) Host: Alec Jessiman.

83. "ELECTRONIC TEXTILES BASED ON INTRINSICALLY CONDUCTING POLYMER FIBRE FOR DEEP SPACE TRAVEL." Massachusetts Institute of Technology, Boston, MA. April 20 (2004) Host: Drs. Newman and Hoffman.

84. "ELECTRONIC TEXTILES BASED ON INTRINSICALLY CONDUCTING POLYMER FIBRE FOR MILITARY APPLICATIONS." U.S. Army Research, Development and

Engineering Command, Natick Soldier Center, Natick, MA. April 21 (2004) Host: Carole Winterhalter.

85. "ELECTRONIC TEXTILES BASED ON INTRINSICALLY CONDUCTING POLYMER FIBRE FOR SURGICAL APPLICATIONS." Boston Scientific Corporation, Natick, MA. April 22 (2004) Host: Steven Walak.

86. "SMART FABRICS AND INTERACTIVE TEXTILES PREPARED FROM ELECTRICALLY CONDUCTIVE FIBRE: NEW CLOTHING PARADIGMS FOR ARCTIC ENVIRONMENT." Alaska High-Technology Summit, Fairbanks, AK. June 16 (2004) Chairmen: Honorable Terry Aldridge (FNSBA) and Mr. Charles Walker (FEDC).

87. "SMART TEXTILE STRUCTURES BASED ON PANION FIBRE." Workshop Regarding SMART Textiles, Ghent University-Department of Textiles, Ghent, Belgium. June 25 (2004) Chairman: Professor Van Langenhove.

88. "ELECTRONIC TEXTILES BASED ON INTRINSICALLY CONDUCTING POLYMER FIBRE." International Conference for Synthetic Metals: Session Regarding Electronic Fibres and Other Unconventional Substrates, Wollongong, Australia. June 29 (2004) Chairman: Geoffry Spinks.

89. "BUSINESS OPPORTUNITIES FOR ELECTRONIC TEXTILES BASED ON INTRINSICALLY CONDUCTING POLYMER FIBRE." International Conference for Synthetic Metals: Session Regarding Business Opportunities in Synthetic Metals and Nanotechnology, Wollongong, Australia. June 30 (2004) Chairman: Gordan Wallace.

90. "ELECTRONIC TEXTILES BASED ON INTRINSICALLY CONDUCTING POLYMER FIBRE." Australian Chemical Society Interact 2004: Session Regarding Conducting Polymers, Gold Coast, Australia. July 6 (2004) Chairman: Prof. Alan Mac Diarmid.

91. "E-Textiles for Microelectronic Packages." Regarding Business Opportunities in Synthetic Metals and Nanotechnology, San Jose, CA. August 13 (2004) Host: Nick Colella.