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STATE OF CALIFORNIA

Energy Resources Conservation
And Development Commission

In the Matter of: Application for Certification For the Palmdale Hybrid Power Project	Docket No. 08-AFC-9

Energy Commission Staff's Prehearing Conference Statement

On January 31, 2011, the Committee assigned to this proceeding issued a Second Revised Notice of Prehearing Conference and Evidentiary Hearing and Order requiring all parties to file Prehearing Conference Statements and specifying what information the prehearing conference statements must contain. Staff provides the requested information below.

Due to a planned vacation, staff must file this prior to receiving the intervenor's testimony on staff's rebuttal testimony. We, therefore, respectfully reserve the right to orally augment this statement at the Prehearing Conference in response to testimony submitted by the intervenors.

Additionally, staff would like to bring to the Committee's attention the issue of alternative routes for the transmission line. The applicant has proposed a route and staff has identified an additional route, Route 4, that it believes is also feasible. Staff and the applicant propose that the Commission certify both routes and let the applicant determine which to construct. Staff recommends that the testimony of both parties on this matter be entered by declaration. If, however, the Committee has questions regarding this issue, staff is able to provide witnesses to answer any questions regarding staff's identified alternative route.

Staff also has included a few items in this submittal. The Visual Resources analysis of the roadpaving proposal was mistakenly left out of the Rebuttal Testimony and is attached to this document along with a declaration by the author. And an analyst's declaration and resume were inadvertently left out of the Final Staff Assessment and are included here to ensure a complete record.

a) **The topic areas that are complete and ready to proceed to evidentiary hearing.**

All topic areas are complete and ready to proceed to evidentiary hearings.

b) The topic areas that are not complete and not yet ready to proceed to evidentiary hearing, and the reasons therefor.

All topic areas are complete and ready to proceed to evidentiary hearings.

c) The topic areas that remain disputed and require adjudication, and the precise nature of the dispute for each topic.

Staff believes that the following items will need adjudication if they are not resolved before the evidentiary hearing.

Biological Resources – Based on discussion at the February 3, 2011 staff workshop, staff understands that the following : BIO-8, 10, 14, 17. The issues involve the necessity of topsoil salvage, the need for the applicant to pay a raven fee for the project site acreage, the need for Swainson's Hawk habitat compensation to consist of a minimum of 366.3 acres of Joshua Tree woodland. Staff believes it is likely that we will be able to come to some agreement with the applicant on the wording of Bio-17 at the workshop staff intends to hold on the morning of February 14, 2011 prior to the Prehearing Conference.

Air Quality – The applicant objects to staff's proposed offset ratio of 1.5:1 instead of 1.3:1 for inter-district/inter-basin ERC transfers for NOx and VOC offsets in AQ-SC18. The applicant is arguing that the AVAQMD offset ratio is applicable to the PHPP ERCs from the SJVAPCD. Rule 1305(C)(3) meets the requirement of HSC section 40709.6 listed below by requiring that:

> "*The ratio for Offsets obtained from outside the District for any Nonattainment Air Pollutant shall be equal to the offset ratio which would have applied had such Offsets been obtained within the District*."

Therefore, from a LORS standpoint, the AVAQMD's 1.3:1 offset ratio would apply. However, given the large distance between the PHPP and proposed offsets, staff believes that the proposed ERCs would not be adequate to demonstrate a new air quality benefit, both under Clean Air Act requirements and under CEQA. The AVAQMD is a very small district that does not have any distance ratios noted in their rules and regulations. Federal guidance on the requirement for a positive net air quality benefit is presented in Appendix S of 40 CFR 51, which requires a demonstration of a positive net air quality benefit that can require modeling if emission offset ratios are insufficient and/or the location of the offsets are significantly different than the emissions being offset. Therefore, the SJVAPCD limitations on the distance between the ERC and new emission source should be considered as a guide in determining the relative effectiveness of the proposed ERCs. SJVAPCD Rule 2201 requires that an offset ratio of 1.5 to 1 be used for all ERCs that are more than 15 miles from the source. To ensure that the project fully mitigates it's impacts, staff believes an offset ratio of 1.5 to 1 is required.

Hazardous Materials Management – Staff does not agree to the applicant's proposed changes to HAZ-2. Staff believes that the preparation of a Process Safety Management Plan and a Spill Prevention and Control Countermeasure Plan are necessary to ensure the proposed project does not result in any significant adverse impacts under CEQA.

The applicant objects to the requirement to prepare and implement a Process Safety Management (PSM) Plan for the HTF system. The applicant disagrees that HTF is "highly flammable" and cites OSHA definitions of a "flammable" material and therefore requests that this requirement be removed.

Staff agrees that at standard temperature and pressure, Therminol is not flammable; it is, however, combustible. However, at the operating temperatures and pressures of a solar power plant, Therminol meets the definition of "flammable" and therefore staff believes that during routine operations and uses of Therminol, it is "highly flammable" Instances of fires were cited by staff in the FSA as well as one case of auto-ignition. However, even if the PSM standard did not apply, staff believes that it is an excellent safety measure that should be required at power plants that use Therminol as the HTF. Staff is not restricted to relying solely on LORS; if that were the case, a SA would not be needed and all staff would have to propose is "comply with all LORS". Since CEQA does not compel or allow staff to rely solely on LORS compliance to mitigate impacts to below a level of significance, staff reiterates its strong recommendation – one that is consistent with the other thermal solar projects that propose to use Therminol as the HTF – to require a PSM Plan.

The applicant also disagrees with staff's proposal to require the preparation of a Spill Prevention, Control, and Countermeasure (SPCC) Plan. The applicant opines that 40 CFR §112.1(d)(1)(i), does not apply.

As stated in the FSA, staff agrees that a SPCC Plan is not required by 40 CFR 112 but is required pursuant to California HSC Sections 25270 through 25270.13. Therefore, the PHPP would be required to prepare a SPCC because it will store 1,320 gallons or more of petroleum (diesel fuel, lube oil, and mineral oil) on-site. Furthermore, as explained above, staff is not obligated to require only those mitigations that are already required by LORS. The preparation and implementation of a SPCC Plan will contribute to reducing the risk of spills occurring and of migrating off-site to a level of insignificance.

Traffic and Transportation – Staff does not accept the applicant's proposed changes to TRANS-1. Because SR-14 and Sierra Highway currently have very poor LOS levels, staff believes it is necessary to ensure that the proposed project does not further degrade those LOS levels and result in a significant adverse impact by restricting all project-related construction-worker traffic along these two roads during peak travel periods. However, staff understands the applicant's concern that restrictions to construction from air quality conditions of certification could, during certain times of the year, impact the applicant's ability to conform to this condition. Therefore, staff will work on possible language to address the applicant's concern and discuss the issue further at the staff workshop on February 14, 2011.

d) The identity of each witness sponsored by each party, the topic area(s) which each witness will present; a brief summary of the testimony to be offered by each witness; qualifications of each witness; the time required to present direct testimony by each witness; and whether the party seeks to have the witness testify in person or telephonically.

The following expert witnesses will represent staff at the evidentiary hearing to testify and be available for cross examination.

Topic Area: Biological Resources
Witness: Chris Huntley
Witness: Erinn Wilson, Staff Environmental Scientist, CDFG
Summary of Testimony: Biological Resources section of the FSA and rebuttal testimony. Staff will respond to the following issues raised by the applicant, if not resolved prior to the evidentiary hearing:

1. Staff and applicant differ on the amount of topsoil required to be salvaged during project construction. The applicant has recently raised concerns about the feasibility of safely storing onsite the amount required under staff's proposed conditions of certification 8 and 10. Staff and applicant have agreed to discuss this issue further at the staff workshop on February 14, 2011.
2. Staff does not agree to applicant's proposed change to Bio-14, and believes the Raven Fee should apply to the project site's acreage in addition to the transmission line acreage.
3. Staff believes that it is important that some of the Swainson's Hawk habitat compensatory mitigation provided under Bio-17 contain Joshua tree woodland. Staff currently has a minimum amount of woodland required in this condition, to which the applicant objects. Staff will work on possibly rewording this requirement to address the applicant's concern about being pinned in by an absolute amount while still ensuring that the condition ensures a certain amount of Joshua tree woodland will be provided.

Qualifications: Resume contained in the FSA

Topic Area: Air Quality
Witness: Steve Radis
Summary of Testimony: Air Quality section of the FSA . Staff will respond to the following issue raised by the applicant and CBD: Staff does

not agree with the applicant’s position that the interdistrict/inter-basin offset ratio in AQ-SC18 should be 1.3 to 1.

Qualifications: Resume contained in the FSA

Topic Area: Hazardous Materials Management
Witness: Dr. Alvin Greenberg
Summary of Testimony: Hazardous Materials Management section of the FSA and Rebuttal Testimony. Staff will respond to the following issue raised by the applicant: Staff and applicant disagree about the necessity of a Process Safety Management Plan and a Spill Prevention and Control Countermeasure Plan, as required by HAZ-2

Qualifications: Resume contained in the FSA

Topic Area: Traffic and Transportation
Witness: James Adams
Summary of Testimony: Traffic and Transportation section of the FSA and Rebuttal Testimony. Staff will respond to the following issue raised by the applicant: Staff does not agree to applicant’s proposed change to TRANS-1 but is working on language that might address the applicant’s concern with implementation of this condition.

Qualifications: James Adams’ resume is contained in the FSA.

For those matters not subject to dispute by the applicant or intervenors, staff proposes to enter testimony into the record by declaration. The testimony and the respective authors are identified below and signed declarations are contained in the FSA and Rebuttal Testimony, where appropriate:

Environmental Analysis
Cultural Resources – Beverly E. Bastian and Pamela Daly
Land Use – Negar Vahidi and Susanne Huerta
Noise and Vibration – Shahab Khoshmashrab and Erin Bright
Public Health and Safety – Alvin Greenberg, Ph.D.
Socioeconomics– Kristin Ford
Soil and Water Resources – Christopher Dennis, PG
Transmission Line Safety and Nuisance – Obed Odoemelam, Ph.D.
Visual Resources – James Adams
Waste Management – Suzanne Phinney, D. Env.
Worker Safety and Fire Protection – Alvin J. Greenberg, Ph.D. and Rick Tyler

Engineering Assessment
Facility Design – Erin Bright
Geology, Paleontology, and Minerals – Dal Hunter, Ph.D., C.E.G.
Power Plant Efficiency – Shahab Khoshmashrab
Power Plant Reliability – Shahab Khoshmashrab
Transmission System Engineering – Laiping Ng and Mark Hesters

Alternatives – Hedy Born Koczwara
Alternatives Appendix A – Suzanne Phinney, D. Env.
General Conditions Including Compliance Monitoring and Closure Plan – Chris Davis

e) Topic areas upon which a party desires to cross-examine witnesses, a summary of the scope of such cross-examination, and the time desired for each such cross-examination.

Staff would like to reserve the right to cross-examine applicant in the following areas if the outstanding issues are not resolved before the evidentiary hearing:

Air Quality – 30 minutes
Biological Resources – 30 minutes
Traffic and Transportation – 15 minutes
Hazardous Materials Management – 30 minutes

Staff respectfully reserves the right to identify times for cross-examining any witnesses the intervenor may produce in the event that intervenor testimony is filed.

f) A list identifying exhibits and declarations that each party intends to offer into evidence and the technical topics to which they apply.

The exhibit list is attached. Staff respectfully reserves the right to identify additional exhibits in the event that intervenor testimony is filed.

g) Topic areas for which the Applicant will seek a commission override due to public necessity and convenience pursuant to Public Resources Code §25525.

Not Applicable.

h) Proposals for briefing deadlines, impact of vacation schedules, and other scheduling matters.

Staff Counsel will be on vacation from March 11, 2011 through March 21, 2011 and respectfully requests that reply briefs be due on March 25, 2011.

i) For all topics, any proposed modifications to the proposed Conditions of Certification listed in the Final Staff Assessment (FSA) based upon enforceability, ease of comprehension, and consistency with the evidence.

Staff agrees to the applicant's proposed changes to the following conditions:

AQ-SC 11, AQT-2, AQT -5, AQT -7, AQT -12, AQT -13, AQT -15, AQT -25, AQAB-8, AQAH-6, ABHH-7, AQEG-3, AQFS-3, BIO-25, PAL-4, TRANS-9, TLSN-4, and VIS-2.

Staff proposes changes to the conditions listed below. For ease of reference, staff lists the condition here and provides the entirety of the condition, with proposed changes in underline/strikeout as an attachment. In general, these changes stem from a realized need for clarification or additional language deemed necessary in response to accepting other changes proposed by the parties.

AQ-SC 19	BIO-13	TRANS-1
AQ-SC 14	BIO-17	TRANS-8
AQ-SC 15	BIO-18	WASTE-2
AQT-16	HAZ-9	

Dated: February 4, 2011

Respectfully submitted,

/s/ Lisa M. Decarlo

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BEFORE THE ENERGY RESOURCES CONSERVATION AND DEVELOPMENT COMMISSION OF THE STATE OF CALIFORNIA
1516 NINTH STREET, SACRAMENTO, CA 95814 - 1-800-822-6228 - WWW.ENERGY.CA.GOV

Docket Number: 08-AFC-9 Date: 1/28/11

Project Name: Palmdale Hybrid Power Project

STAFF EXHIBIT LIST

Exhibit	Witness	Brief Description	Offered	Admitted
300	Various	Final Staff Assessment dated December 22, 2010 and docketed December 22, 2010 (a) Air Quality (b) Biological Resources (c) Cultural Resources (d) Hazardous Materials (e) Land Use (f) Noise and Vibration (g) Public Health (h) Socioeconomic Resources (i) Soil and Water Resources (j) Traffic and Transportation (k) Transmission Line Safety and Nuisance (l) Visual Resources (m) Waste Management (n) Worker Safety (o) Facility Design (p) Geology and Paleontology (q) Power Plant Efficiency (r) Power Plant Reliability (s) Transmission System Engineering (t) Alternatives (u) Alternatives Appendix A (v) General Conditions		

301	**Various**	**Staff's Rebuttal Testimony** (a) **Biological Resources** (b) **Cultural Resources** (c) **Geology and Paleontology** (d) **Hazardous Materials Management** (e) **Land Use** (f) **Public Health** (g) **Socioeconomics** (h) **Soil and Water Resources** (i) **Traffic and Transportation** (j) **Worker Safety and Fire Protection**		
302	**Steve Radis**	**Antelope Valley Air Quality Management District Final Determination of Compliance, Palmdale Hybrid Power Project, May 13, 2010**		
303	**Chris Huntley**	**Reducing Predation by Common Ravens on Desert Tortoises in the Mojave and Colorado Deserts, USGS, July 18, 2002**		
304	**Chris Huntley**	**Environmental Assessment to Implement a Desert Tortoise Recovery Plan Task: Reduce Common Raven Predation on the Desert Tortoise, Final, USFWS, March 2008**		
305	**Chris Huntley**	**Region 8 Interim Guidelines for the Development of a Project-Specific Avian and Bat Protection Plan for Solar Energy Plants and Related Transmission Facilities, USFWS Pacific Southwest Region, September 2, 2010**		
306	**Jim Adams**	**Energy Commission Staff's Prehearing Conference Statement** (a) **Visual Resources**		

STAFF PROPOSED CHANGES TO CONDITIONS OF CERTIFICATION IN PALMDALE 2-3-11

AQ-SC19 The project owner shall provide 137 tons per year of PM10 ERCs (128 tons per year for PM10 emissions and 9 tons per year for PM10-precursor SOx emissions) that are banked consistent with the Rules and Regulations of the AVAQMD. ~~Once the District has adopted one or more rules to bank PM offsets from road paving,~~Should the project owner pursue road paving as the method to obtain the necessary PM10 ERCs, the project owner shall pave, with asphalt concrete that meets the current county road standards, unpaved local roads to provide emission reductions of 137 tons per year of PM10, prior to start of construction of the project. The project owner shall submit a road paving plan that includes a list and pictures of candidate roads to be paved, their actual daily average traffic count including classifications of vehicles (ADT), and daily vehicle miles travel (DVMT), their actual road dust silt content, and calculations showing the appropriate amount of emissions reductions due to paving of each road segment. Calculations of PM10 emission reduction credits shall be performed in accordance with Sections 13.2.1 and 13.2.2 of the U.S. EPA's AP-42 "Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources", Fifth Edition.

Should the project owner pursue an alternate method of obtaining PM10 ERCs, such as inter-pollutant trading of NOx and SOx for PM10, the project owner shall provide, at a minimum, NOx and SOx ERCs at ratios of 2.629:1 and 1:1, respectively, per guidance from SJVAPCD rules.

Verification: At least ~~one year~~ 30 days prior to start of construction, the project owner shall submit documentation showing that the project has obtained 137 tons of banked PM10 ERCs. If the project owner chooses to use road paving to obtain the necessary ERCs, the project owner shall submit to the CPM for review and approval, the road paving plan 30 days prior to submittal of the plan to the AVAQMD. ~~plans and other documents to demonstrate compliance with this condition.~~ Construction shall not begin until the CPM has approved all ~~ERCS~~ERCs. This approval shall be done in consultation with the District. ~~Documents shall include a list and pictures of candidate roads to be paved, their actual daily average traffic count including classifications of vehicles (ADT), and daily vehicle miles travel (DVMT), their actual road dust silt content, and calculations showing the appropriate amount of emissions reductions due to paving of each road segment.~~ All paving of roads done for PM-10 offset purposes shall be completed at least 15 days prior to start construction of the project.

AQ-SC14 Expansion tank roof appurtenances shall not exhibit emissions exceeding 10,000-ppmv as methane measured with an instrument calibrated with methane and conducted in accordance with ~~U.S.~~EPA Method 21 or equivalent. All accessible valves, connectors, and PRV's (including rupture disks) shall be inspected quarterly using an AVAQMD approved leak detection device calibrated for methane.

Verification: The project owner shall make the site available for inspection of records and equipment by representatives of the District, ARB, and the Energy Commission.

AQ-SC15 Each expansion tank shall be maintained leak-free. A "leak" is defined as the dripping of liquid volatile organic compounds at a rate of three or more drops per minute, or vapor volatile organic compounds in excess of 10,000-ppm as equivalent methane as determined by EPA Test Method 21 <u>or equivalent. All accessible valves, connectors, and PRV's (including rupture disks) shall be inspected quarterly using an AVAQMD approved leak detection device calibrated for methane.</u>

Verification: The project owner shall make the site available for inspection of records and equipment by representatives of the District, ARB, and the Energy Commission.

AQT-16 Continuous monitoring systems shall meet the following acceptability testing requirements from 40 CFR 60 Appendix B (or otherwise District approved): a. For NOx, ~~Performance Specification 2~~.<u>40 CFR 75</u>.

…

Verification: ~~At least 60 days prior to construction of the turbine stacks, the project owner shall provide the District and CPM, for approval, a detailed drawing and a plan on how the measurements and recordings, required by this condition, will be performed by the chosen monitoring system.~~ <u>The owner/operator shall install, calibrate, maintain, and operate these monitoring systems according to a District-approved monitoring plan and AVAQMD Rule 218, and they shall be installed prior to initial equipment startup after initial steam blows are completed. Sixty (60) days prior to installation, the operator shall submit a monitoring plan for District review and approval and the CPM for review.</u>

DESERT TORTOISE CLEARANCE SURVEYS AND EXCLUSION FENCING

BIO-13 The project owner shall undertake appropriate measures to manage construction at the plant site and linear facilities in a manner to avoid impacts to desert tortoise. Methods for clearance surveys, fence installation, and other procedures shall be consistent with those described in the *Guidelines for Handling Desert Tortoise During Construction Projects* (Desert Tortoise Council 1999) or more current guidance provided by CDFG and USFWS. These measures include, but are not limited to, the following:

1. <u>Fence Installation</u>. Prior to ground disturbance, the entire plant site shall be fenced with permanent desert tortoise-exclusion fence. To avoid impacts to desert tortoise during fence construction, the proposed fence alignment shall be flagged and the alignment surveyed within 24 hours prior to fence construction. Surveys shall be conducted by the Designated Biologist using techniques approved by the USFWS and CDFG. Biological Monitors may assist the Designated Biologist under his or her supervision. These surveys shall provide 100% coverage of all areas to be disturbed during fence construction and an additional transect along both sides of the proposed fence line. This fence line transect shall cover an area approximately 90 feet wide centered on the fence alignment. Transects shall be no greater than 30 feet apart. All desert tortoise burrows, and burrows constructed by other species that might be used by desert

tortoises, shall be examined to assess occupancy of each burrow by desert tortoises and handled in accordance with USFWS-approved protocol.

a. Timing, Supervision of Fence Installation. The exclusion fencing shall be installed prior to the onset of site clearing and grubbing. The fence installation shall be supervised by the Designated Biologist and monitored by the Biological Monitors to ensure the safety of any tortoise present.

b. Fence Material and Installation. The permanent tortoise exclusionary fencing shall be constructed in compliance with current USFWS guidelines. ~~consist of galvanized hard wire cloth 1 by 2 inch mesh sunk 12 inches into the ground, and 24 inches above ground (USFWS 2008b, Appendix D).~~

c. Security Gates. Security gates shall be designed with minimal ground clearance to deter ingress by tortoises, including gates that would exclude public access to the PHPP site.

d. Tower Fencing. If tortoises are discovered during clearance surveys of the linear routes, the tower locations shall be temporarily fenced with tortoise exclusion fencing to prevent desert tortoise entry during construction. Temporary fencing must follow current USFWS guidelines for permanent fencing and supporting stakes shall be sufficiently spaced to maintain fence integrity.

e. Fence Inspections. Following installation of the desert tortoise exclusion fencing for both the permanent site fencing and temporary fencing in the utility corridors, the fencing shall be regularly inspected. Permanent fencing shall be inspected monthly and during/following all major rainfall events. Any damage to the fencing shall be temporarily repaired immediately to keep tortoises out of the site, and permanently repaired within two days of observing damage. Inspections of permanent site fencing shall occur for the life of the project. Temporary fencing must be inspected weekly and, where drainages intersect the fencing, during and immediately following major rainfall events. All temporary fencing shall be repaired immediately upon discovery and, if the fence may have permitted tortoise entry while damaged, the Designated Biologist shall inspect the utility corridor or tower site for tortoise.

2. Desert Tortoise Clearance Surveys. Following construction of the tortoise exclusionary fencing around the Plant Site, all fenced areas shall be cleared of tortoises by the Designated Biologist, who may be assisted by Biological Monitors. A minimum of two clearance surveys, with negative results, must be completed, and these must coincide with heightened desert tortoise activity from late March through May and during October. To facilitate seeing the ground from different angles, the second clearance survey shall be walked at 90 degrees to the orientation of the first clearance survey.

3. Relocation for Desert Tortoise. If desert tortoises are detected on the PHPP plant site during clearance or other activities, the owner shall halt ground disturbing activities within 500 feet of the tortoise, prepare a Desert Tortoise Translocation Plan, and coordinate with the USFWS, CDFG, and CPM regarding the

disposition of the animals. If located during clearance surveys within the transmission line project-project route, the tortoise would be allowed to continue unimpeded out of harm's way. ~~impact area~~ Only in the event that a tortoise required relocation to prevent injury the Designated Biologist shall move the tortoise the shortest possible distance, keeping it out of harm's way but still within its home range. Desert tortoise encountered during construction of any of the utility corridors shall be similarly treated in accordance with the techniques described in the *Guidelines for Handling Desert Tortoise during Construction Projects* (Desert Tortoise Council 1999) or more current guidance on the USFWS website. Any person handling tortoise must be ~~trained and~~ approved by the USFWS and CDFG and be on site during ground disturbance or construction. If a desert tortoise is discovered on the PHPP power plant site the project owner shall prepare a Desert Tortoise Translocation Plan. The Translocation Plan shall follow the most current USFWS guidelines for the translocation of desert tortoise and shall be submitted to the USFWS, CDFG, and CPM for approval. Desert tortoise shall not be moved pending the approval of the Plan. Prior to initiating further ground disturbance at the project site the project owner shall conduct additional clearance surveys of the power plant site. ~~A site where tortoises will be moved must be pre-approved, and acquired prior to ground disturbing activities. The health of any tortoise to be translocated must be assessed prior to moving; a quarantine site located for any ill tortoise must be designated. The host population of tortoise surveyed prior to any translocated tortoise being moved, and a study to determine the efficacy of the translocation and impact to host population be conducted for a minimum of 5 years.~~

4. Burrow Inspection. All potential desert tortoise burrows within the fenced area shall be searched for presence. In some cases, a fiber optic scope may be needed to determine presence or absence within a deep burrow. To prevent reentry by a tortoise or other wildlife, all burrows shall be collapsed once absence has been determined. ~~Tortoises excavated from burrows shall be translocated to unoccupied natural or artificial burrows immediately following excavation in an area approved by the Designated Biologist if environmental conditions warrant immediate relocation.~~

5. Burrow Excavation. Burrows inhabited by tortoises shall be excavated by the Designated Biologist or other USFWS/CDFG/CPM approved handler, using hand tools, and then collapsed or blocked to prevent re-occupation. If excavated during May through July, the Designated Biologist shall search for desert tortoise nests/eggs. All desert tortoise handling and removal, and burrow excavations, including nests, shall be conducted by the Designated Biologist or other USFWS/CDFG/CPM approved handler (See Paragraph 3 above) in accordance with the USFWS-approved protocol (Desert Tortoise Council 1999) or more current guidance on the USFWS website.

6. Monitoring During Clearing. Following construction of the desert tortoise exclusion fencing and clearance surveys ~~desert tortoise clearance removal from the plant site and translocation to a new site~~, heavy equipment shall be allowed to enter the project site to perform earth work such as clearing, grubbing, leveling, and trenching. A Biological Monitor shall be onsite during initial clearing and grading activities. Should a tortoise be discovered, the measures outlined in

Paragraph 3 shall be followed~~. it shall be translocated as described above in accordance with the Desert Tortoise Translocation Plan.~~

7. Reporting. The Designated Biologist shall record the following information for any desert tortoises observed or handled: a) the locations (narrative and maps) and dates of observation; b) general condition and health, including injuries, state of healing and whether desert tortoise voided their bladders; c) location moved from and location moved to (using GPS technology); d) gender, carapace length, and diagnostic markings (i.e., identification numbers or marked lateral scutes); e) ambient temperature when handled and released; and f) digital photograph of each handled desert tortoise as described in the paragraph below. Desert tortoise moved from within project areas shall be marked for future identification as described in *Guidelines for Handling Desert Tortoise during Construction Projects* (Desert Tortoise Council 1999) or more current guidance on the USFWS website. Digital photographs of the carapace, plastron, and fourth costal scute shall be taken. Scutes shall not be notched for identification. Any desert tortoises observed within the project area or adjacent habitat shall be reported to the USFWS, CDFG, and CPM by written and electronic correspondence within 24 hours.

Verification: ~~No less than 60 days prior to start of any site mobilization or disturbance activities, the applicant shall submit to Energy Commission Staff, USFWS and CDFG a draft Desert Tortoise Translocation Plan. At least 60 days prior to start of any project-related ground disturbance activities, the project owner shall provide the CPM with the final version of a Translocation Plan that has been approved by Energy Commission staff in consultation with USFWS and CDFG. The CPM will determine the plan's acceptability within 15 days of receipt of the final plan. All modifications to the approved Desert Tortoise Translocation Plan must be made only after approval by the Energy Commission staff in consultation with USFWS and CDFG. The project owner shall notify the CPM no fewer than 5 working days before implementing any CPM-approved modifications to the Translocation Plan.~~

~~Within 30 days after initiation of translocation activities, the Designated Biologist shall provide to the CPM for review and approval, a written report identifying which items of the Translocation Plan have been completed, and a summary of all modifications to measures made during implementation.~~

Within 30 days of completion of desert tortoise clearance surveys the Designated Biologist shall submit a report to the CPM, USFWS, and CDFG describing how each of the mitigation measures described above has been satisfied. The report shall include the desert tortoise survey results, capture and release locations of any relocated desert tortoises, and any other information needed to demonstrate compliance with the measures described above.

If a desert tortoise is located on the power plant site the project owner shall submit to Energy Commission Staff, USFWS and CDFG a draft Desert Tortoise Translocation Plan. The CPM will review the Plan and provide comments within 30 days receipt of the draft plan. All modifications to the Desert Tortoise Translocation Plan must be made only after approval by the Energy Commission staff in consultation with USFWS and CDFG. The project owner shall notify the CPM no fewer than 5 working days before implementing any CPM-approved modifications to the Translocation Plan.

Within 30 days after initiation of translocation activities, the Designated Biologist shall provide to the CPM for review and approval, a written report identifying which items of the Translocation Plan have been completed, and a summary of all modifications to measures made during implementation.

Swainson's Hawk HABITAT COMPENSATORY MITIGATION

BIO-17 The project owner shall either assume that Swainson's hawk nest within five miles of the project site and provide compensatory mitigation as described below or complete CFDG protocol surveys within five miles of project facilities that result in permanent impacts to Swainson's hawk foraging habitat. If surveys are completed they shall include the following components.

The survey periods shall follow a specified schedule: Period I occurs from 1 January to 31 March, Period II occurs from 1 April to 30 April, Period III occurs from 1 may to 30 May, and Period IV occurs from 1 June to 15 July. No fewer than three surveys per period in at least two survey periods shall be completed immediately prior to the start of project construction. All nest sites shall be recorded, mapped using GIS and provided to the CPM and CDFG. Compensatory mitigation at a 2:1 ratio shall be required for permanent impacts. If active Swainson's hawk nests (i.e., any nest active within five years) are not detected within 5 miles of the project site or linear facilities, the project owner will not be required to provide compensatory mitigation.

If the project owner assumes presence, the project owner shall provide compensatory mitigation acreage for 610 acres of Swainson's hawk habitat lands, adjusted to reflect the final project footprint, as specified in this condition. In addition, the project owner shall provide funding for initial improvement and long-term maintenance, enhancement, and management of the acquired lands for protection and enhancement Swainson's hawk populations, and comply with other related requirements of this condition.

a. Loss of foraging habitat for Swainson's hawks shall be mitigated by providing Habitat Management (HM) lands at a ratio of 2:1 for any foraging habitat impacted within a 5-mile radius of active Swainson's hawk nest(s) (CDFG considers a nest active if it was used one or more times within the last 5 years). Foraging habitat includes but is not limited to alfalfa; fallow fields; beet, tomato, onions, and other low-growing row or field crops; dry-land and irrigated pasture; and cereal grain crops (including corn after harvest). Joshua tree woodland shall be considered foraging habitat in the Antelope Valley.

b. Lands which are currently in urban use or lands that have no existing or potential value for foraging Swainson's hawks will not require mitigation. The project owner will provide the CPM and CDFG a report of potential foraging lands impacted by the proposed project as determined by consultation with the CDFG and recent site-specific surveys conducted by a CDFG-qualified raptor biologist.

This acreage was calculated as follows: a ratio of 2:1 for the PHPP power plant site (610 acres) and a 2:1 ratio (10.22 acres) for the loss of agricultural lands associated with Segment 1 of the transmission line. Costs of these requirements are estimated to be $9,000,550.00 (see **Biological Resources Tables 4a** for a complete breakdown of costs and acreage). All costs are best estimates as of fall 2010. Actual costs will be determined at the time of the transactions and may change the funding needed to implement the required mitigation obligation based on changing land costs or management fees. Regardless of the estimates, the project owner is responsible for providing adequate funding to implement the required mitigation.

These impact acreages shall be adjusted to reflect the final project footprint. For purposes of this condition, the Project footprint means all lands disturbed in the construction and operation of the Palmdale Hybrid Power Plant Project Site and 10.22 acres of agricultural lands that occur on Segment 1.

This compensation acreage may be included ("nested") within the acreage acquired and managed as Mohave ground squirrel habitat compensation (Condition of Certification **BIO-20**) only if:

- A minimum of 610 acres of suitable foraging habitat including a minimum of 366.3 acres of Joshua tree woodland~~, 233.1 acres of Mojave creosote bush scrub and 10 acres of agricultural lands~~ are present.
- The Mohave ground squirrel habitat compensation lands are acquired and dedicated as permanent conservation lands within 18 months of the start of project construction.

If these two criteria are not met, then the project owner shall provide the required number of acres of Swainson's hawk habitat compensation lands, adjusted to reflect the final project footprint and additional delineation of suitable habitat, independent of any compensation land required under other conditions of certification, and shall also provide funding for the initial improvement and long-term maintenance and management of the acquired lands, and shall comply with other related requirements this condition.

The project owner shall provide financial assurances as described below in the amount of $9,000,550.00. In lieu of acquiring lands itself, the Project owner may satisfy the requirements of this condition by depositing funds into a Renewable Energy Action Team (REAT) Account established with the National Fish and Wildlife Foundation (NFWF), as described below. If the Project owner elects to establish a REAT NFWF Account and have NFWF and the agencies complete the required habitat compensation, then the total estimated cost of complying with this condition is $9,252,876.50. The amount of security or NFWF deposit shall be adjusted up or down to reflect any revised cost estimates recommended by REAT.

The actual costs to comply with this condition will vary depending on the final footprint of the project, the costs of acquiring compensation habitat, the costs of initially improving the habitat, and the actual costs of long-term management as determined by a Property Analysis Report or similar analysis (below). The 610 acre habitat requirement, and associated funding requirements based on that acreage, shall be adjusted up or down if there are changes in the final footprint of the project or the associated costs of evaluation, acquisition, management, and other factors listed in **Biological Resources Tables 4a**. Regardless of actual cost, the project owner shall be responsible for funding all requirements of this condition.

COMPENSATORY MITIGATION LAND ACQUISITION

1. Method of Acquisition. Compensation lands shall be acquired by either of the two options listed below. Regardless of the method of acquisition, the transaction shall be complete only upon completion of all terms and conditions described in this Condition of Certification.

a. The project owner shall acquire lands and transfer title and/or conservation easement to a state or federal land management agency or to a third-party non-profit land management organization, as approved by the CPM in consultation with CDFG; or

b. The Project owner shall deposit funds into a project-specific subaccount within the REAT Account established with the NFWF, in the amount as indicated in **Biological Resources Tables 4a** (adjusted to reflect final project footprint and any applicable REAT adjustments to costs).

2. Selection Criteria for Compensation Lands. The compensation lands selected for acquisition to meet Energy Commission and CESA requirements shall be equal to or better than the quality and function of the habitat impacted and:

   a. Be within the Western Mojave Desert;

   b. Provide moderate to good quality foraging habitat for Swainson's hawk with capacity to improve in quality and value for this species; and

   c. Be near lands for which there is reasonable evidence (for example, recent (<15 years) CNDDB occurrences on or immediately adjacent to the proposed lands) suggesting current occupation by Swainson's hawk ideally with populations that are stable, recovering, or likely to recover.

   d. be near larger blocks of lands that are either already protected or planned for protection, or which could feasibly be protected long-term by a public resource agency or a non-governmental organization dedicated to habitat preservation;

   e. not have a history of intensive recreational use or other disturbance that might cause future erosional damage or other habitat damage, and make habitat recovery and restoration infeasible;

   f. not be characterized by high densities of invasive species, either on or immediately adjacent to the parcels under consideration, that might jeopardize habitat recovery and restoration; and

   g. not contain hazardous wastes that cannot be removed to the extent that the site could not provide suitable habitat; and

h. have water and mineral rights included as part of the acquisition, unless the CPM, in consultation with CDFG, agrees in writing to the acceptability of land without these rights.

3. Review and Approval of Compensation Lands Prior to Acquisition. The project owner shall submit a formal acquisition proposal to the CPM describing the parcel(s) intended for purchase. This acquisition proposal shall discuss the suitability of the proposed parcel(s) as compensation lands for Swainson's hawk in relation to the criteria listed above and must be approved by the CPM. The CPM will share the proposal with and consult with CDFG before deciding whether to approve or disapprove the proposed acquisition.

4. Compensation Lands Acquisition Conditions: The project owner shall comply with the following conditions relating to acquisition of the compensation lands after the CPM, in consultation with CDFG approved the proposed compensation lands:

   a. Preliminary Report: The Project owner, or approved third party, shall provide a recent preliminary title report, initial hazardous materials survey report, biological analysis, and other necessary or requested documents for the proposed compensation land to the CPM. All documents conveying or conserving compensation lands and all conditions of title are subject to review and approval by the CPM, in consultation with CDFG. For conveyances to the State, approval may also be required from the California Department of General Services, the Fish and Game Commission and the Wildlife Conservation Board.

   b. Title/Conveyance: The Project owner shall acquire and transfer fee title to the compensation lands, a conservation easement over the lands, or both fee title and conservation easement as required by the CPM in consultation with CDFG. Any transfer of a conservation easement or fee title must be to CDFG, a non-profit organization qualified to hold title to and manage compensation lands (pursuant to California Government Code section 65965), or to other public agency approved by the CPM in consultation with CDFG. If an approved non-profit organization holds fee title to the compensation lands, a conservation easement shall be recorded in favor of CDFG or another entity approved by the CPM. If an approved non-profit holds a conservation easement, CDFG shall be named a third party beneficiary. If an entity other than CDFG holds a conservation easement over the compensation lands, the CPM may require that CDFG or another entity approved by the CPM, in consultation with CDFG, be named a third party beneficiary of the conservation easement. The Project owner shall obtain approval of the CPM, in consultation with CDFG, of the terms of any transfer of fee title or conservation easement to the compensation lands.

   c. Property Analysis Record. Upon identification of the compensation lands, the Project owner shall conduct a Property Analysis Record (PAR) or PAR-like analysis to establish the appropriate amount of the long-term maintenance and management fund to pay the in-perpetuity management of the compensation lands. The PAR or PAR-like analysis must be approved by the CPM, in consultation with CDFG, before it can be used to establish funding levels or management activities for the compensation lands.

5. Compensation Lands Acquisition Costs: The Project owner shall pay all other costs related to acquisition of compensation lands and conservation easements. In addition to actual land costs, these acquisition costs shall include but shall not be limited to the items listed below. Management costs including site cleanup measures are described separately, in the following section.

a. Level 1 Environmental Site Assessment;

b. Appraisal;

c. Title and document review costs;

d. Expenses incurred from other state, federal, or local agency reviews;

e. Closing and escrow costs;

f. Overhead costs related to providing compensation lands to CDFG or an approved third party;

g. Biological survey(s) to determine mitigation value of the land; and

h. Agency costs to accept the land (e.g., writing and recording of conservation easements; title transfer).

COMPENSATORY MITIGATION LAND IMPROVEMENT

1. Land Improvement Requirements: The Project owner shall fund activities that the CPM, in consultation with the CDFG, requires for the initial protection and habitat improvement of the compensation lands. These activities will vary depending on the condition and location of the land acquired, but may include surveys of boundaries and property lines, installation of signs, trash removal and other site cleanup measures, construction and repair of fences, invasive plant removal, removal of roads, and similar measures to protect habitat and improve habitat quality on the compensation lands.

   The costs of these activities are estimated at $250 an acre, but will vary depending on the measures that are required for the compensation lands. A non-profit organization, CDFG or another public agency may hold and expend the habitat improvement funds if it is qualified to manage the compensation lands (pursuant to California Government Code section 65965), if it meets the approval of the CPM in consultation with CDFG, and if it is authorized to participate in implementing the required activities on the compensation lands. If CDFG takes fee title to the compensation lands, the habitat improvement fund must be paid to CDFG or its designee.

COMPENSATORY MITIGATION LAND LONG-TERM MANAGEMENT

1. Long-term Management Requirements: Long-term management is required to ensure that the compensation lands are managed and maintained to protect and enhance habitat for desert tortoise. Management activities may include maintenance of signs, fences, removal of invasive weeds, monitoring, security and enforcement, and control or elimination of unauthorized use.

2. Long-term Management Plan. The project owner shall pay for the preparation of a Management Plan for the compensation lands. The Management Plan shall

reflect site-specific enhancement measures on the acquired compensation lands. The plan shall be submitted for approval of the CPM, in consultation with CDFG.

3. Long-Term Maintenance and Management Funding. The Project owner shall provide money to establish an account with a non-wasting capital that will be used to fund the long-term maintenance and management of the compensation lands. The amount of money to be paid will be determined through an approved PAR or PAR-like analysis conducted for the compensation lands. The amount of required funding is initially estimated to be $1,450 for every acre of compensation lands. If compensation lands will not be identified and a PAR or PAR-like analysis completed within the time period specified for this payment (see the verification section at the end of this condition), the Project owner shall provide initial payment of $854,500.00 calculated at $1,450 an acre for each compensation acre, as shown in **Biological Resources Tables 4a** (above) into an account for long-term maintenance and management of compensation lands. The amount of the required initial payment or security for this item shall be adjusted for any change in the Project footprint as described above. If an initial payment is made based on the estimated per-acre costs, the project owner shall deposit additional money as may be needed to provide the full amount of long-term maintenance and management funding indicated by a PAR or PAR-like analysis, once the analysis is completed and approved. If the approved analysis indicates less than $1,450 an acre will be required for long-term maintenance and management, the excess paid will be returned to the Project owner.

   The project owner must obtain the CPM's approval of the entity that will receive and hold the long-term maintenance and management fund for the compensation lands. The CPM will consult with the project owner and CDFG before deciding whether to approve an entity to hold the project's long-term maintenance and management funds on any lands. The CPM, in consultation with the project owner and CDFG, may designate another state agency or non-profit organization to hold the long-term maintenance and management fee if the organization is qualified to manage the compensation lands in perpetuity.

   If CDFG takes fee title to the compensation lands, CDFG shall determine whether it will hold the long-term management fee in the special deposit fund, leave the money in the REAT Account, or designate another entity such as NFWF to manage the long-term maintenance and management fee for CDFG and with CDFG supervision.

   The Project owner shall ensure that an agreement is in place with the long-term maintenance and management fee holder/manager to ensure the following conditions:

   i. Interest. Interest generated from the initial capital shall be available for reinvestment into the principal and for the long-term operation, management, and protection of the approved compensation lands, including reasonable administrative overhead, biological monitoring, improvements to carrying capacity, law enforcement measures, and any other action approved by CDFG designed to protect or improve the habitat values of the compensation lands.

   ii. Withdrawal of Principal. The long-term maintenance and management fee principal shall not be drawn upon unless such withdrawal is deemed necessary by the CPM, in consultation with CDFG, or the approved third-party long-term maintenance and management fee manager to ensure the continued viability of the species on the compensation lands. If CDFG takes fee title to the compensation lands, monies received by CDFG pursuant to this provision shall be deposited in a special deposit fund established solely for the purpose to manage lands in perpetuity unless CDFG designates NFWF or another entity to manage the long-term maintenance and management fee for CDFG.

iii. Pooling Funds. A CPM- approved non-profit organization qualified to hold long-term maintenance and management fees solely for the purpose to manage lands in perpetuity, may pool the fund with other funds for the operation, management, and protection of the compensation lands for local populations of desert tortoise. However, for reporting purposes, the long-term maintenance and management fee fund must be tracked and reported individually to the CDFG and CPM.

iv. Reimbursement Fund. The project owner shall provide reimbursement to CDFG or an approved third party for reasonable expenses incurred during title, easement, and documentation review; expenses incurred from other State or State-approved federal agency reviews; and overhead related to providing compensation lands.

COMPENSATORY MITIGATION LAND SECURITY

1. Compensation Mitigation Security: The project owner shall provide security sufficient for funding acquisition, improvement, and long-term management of Swainson's hawk compensation land. Financial assurance can be provided to the CPM in the form of an irrevocable letter of credit, a pledged savings account or another form of security ("Security"). Prior to submitting the Security to the CPM, the Project owner shall obtain the CPM's approval, in consultation with CDFG of the form of the Security.

   The security amount shall be based on the estimates provided in **Biological Resources Tables 4a.** This amount shall be updated and verified prior to payment and shall be adjusted to reflect actual costs or more current estimates as agreed upon by the REAT agencies.

   The Project owner shall provide verification that financial assurances have been established to the CPM with copies of the document(s) to CDFG, to guarantee that an adequate level of funding is available to implement any of the mitigation measures required by this condition that are not completed prior to the start of ground-disturbing activities described in Section A of this condition.

   In the event that the project owner defaults on the Security, the CPM may use money from the Security solely for implementation of the requirements of this condition. The CPM's use of the security to implement measures in this condition may not fully satisfy the Project owner's obligations under this condition. Any amount of the Security that is not used to carry out mitigation shall be returned to the Project owner upon successful completion of the associated requirements in this condition.

   Security for the requirements of this condition shall be provided in the amount of $9,252,876.50 if the project owner elects to use the REAT Account with NFWF pursuant to paragraph 4 of this condition, below). The Security is calculated in part from the items that follow but adjusted as specified below (consult **Biological Resources Tables 4a** for the complete breakdown of estimated costs). However, regardless of the amount of the security or actual cost of implementation, the project owner shall be responsible for implementing all aspects of this condition.

i. land acquisition costs for compensation land, calculated at $10,000/acre;

ii. Site assessments, appraisals, biological surveys, transaction closing and escrow costs, calculated as $18,000 total per parcel (presuming 60 acres per parcel)

iii. Initial site clean-up, restoration, or enhancement, calculated at $250/acre;

iv. Third-party and agency administrative transaction costs and overhead, calculated as percentages of land cost;

v. Long-term management and maintenance fund, calculated at $1,450 per acre;

vi. NFWF fees to establish a project-specific account; manage the sub-account for acquisition and initial site work; and manage the sub-account for long term management and maintenance.

2. The project owner may elect to comply with some or all of the requirements in this condition by providing funds to implement the requirements into the Renewable Energy Action Team (REAT) Account established with the National Fish and Wildlife Foundation (NFWF). To use this option, the Project owner must make an initial deposit to the REAT Account in an amount equal to the estimated costs of implementing the requirement (as set forth in the Security section of this condition, paragraph 3, above). If the actual cost of the acquisition, initial protection and habitat improvements, long-term funding or other cost is more than the estimated amount initially paid by the project owner, the project owner shall make an additional deposit into the REAT Account sufficient to cover the actual acquisition costs, the actual costs of initial protection and habitat improvement on the compensation lands, the long-term funding requirements as established in an approved PAR or PAR-like analysis, or the other actual costs that are estimated in the table. If those actual costs or PAR projections are less than the amount initially transferred by the applicant, the remaining balance shall be returned to the project owner.

4. The responsibility for acquisition of compensation lands may be delegated to a third party other than NFWF, such as a non-governmental organization supportive of desert habitat conservation, by written agreement of the Energy Commission. Such delegation shall be subject to approval by the CPM, in consultation with CDFG prior to land acquisition, enhancement or management activities. Agreements to delegate land acquisition to an approved third party, or to manage compensation lands, shall be executed and implemented within 18 months of the Energy Commission's certification of the project.

5. The project owner may request the CPM to provide it with all available information about any funds held by the Energy Commission, CDFG or NFWF as project security, or funds held in a NFWF sub-account for this project, or other project-specific account held by a third party. The CPM shall also fully cooperate

with any independent audit that the project owner may choose to perform on any of these funds.

Verification: The project owner shall provide the CPM with either the results of the nesting surveys or written verification that the project owner shall assume presence no less than 60 days prior to ground disturbance or site mobilization. on the project site.

If the mitigation actions required under this condition are not completed at least 30 days prior to the start of ground-disturbing activities, the Project owner shall provide verification to the CPM and CDFG that an approved Security has been established in accordance with this condition of certification no later than 30 days prior to beginning Project ground-disturbing activities. Financial assurance can be provided to the CPM in the form of an irrevocable letter of credit, a pledged savings account or another form of security ("Security"). Prior to submitting the Security to the CPM, the project owner shall obtain the CPM's approval, in consultation with CDFG of the form of the Security. The project owner, or an approved third party, shall complete and provide written verification to the CPM and CDFG of the compensation lands acquisition and transfer within 18 months of the start of Project ground-disturbing activities.

No later than 12 months after the start of any ground-disturbing project activities, the project owner shall submit a formal acquisition proposal to the CPM describing the parcel(s) intended for purchase, and shall obtain approval from the CPM, in consultation with CDFG prior to the acquisition. If NFWF or another approved third party is handling the acquisition, the project owner shall fully cooperate with the third party to ensure the proposal is submitted within this time period. The project owner or an approved third party shall complete the acquisition and all required transfers of the compensation lands, and provide written verification to the CPM and CDFG of such completion, no later than 18 months after the issuance of the Energy Commission Decision.

The project owner shall complete and submit to the CPM a PAR or PAR-like analysis no later than 60 days after the CPM approves compensation lands for acquisition associated with any phase of construction. The project owner shall fully fund the required amount for long-term maintenance and management of the compensation lands for that phase of construction no later than 30 days after the CPM approves a PAR or PAR-like analysis of the anticipated long-term maintenance and management costs of the compensation lands. Written verification shall be provided to the CPM and CDFG to confirm payment of the long-term maintenance and management funds.

No later than 60 days after the CPM determines what activities are required to provide for initial protection and habitat improvement on the compensation lands for any phase of construction, the project owner shall make funding available for those activities and provide written verification to the CPM of what funds are available and how costs will be paid. Initial protection and habitat improvement activities on the compensation lands for that phase of construction shall be completed, and written verification provided to the CPM, no later than six months after the CPM's determination of what activities are required on the compensation lands.

The project owner, or an approved third party, shall provide the CPM and CDFG with a management plan for the compensation lands associated with any phase of construction within 180 days of the land or easement purchase, as determined by the date on the title. The CPM, in consultation with CDFG shall approve the management plan after its content is acceptable to the CPM.

Within 90 days after completion of all project related ground disturbance, the project owner shall provide to the CPM and CDFG an analysis, based on aerial photography, with the final accounting of the amount of habitat disturbed during Project construction. If this analysis shows that more lands were disturbed than was anticipated in this condition, the project owner shall provide the Energy Commission with additional compensation lands and funding commensurate with the added impacts and applicable mitigation ratios set forth in this condition. A final analysis of all project related ground disturbance may not result in a reduction of compensation requirements if the deadlines established under this condition for transfer of compensation lands and funding have passed prior to completion of the analysis.

Burrowing Owl Impact Avoidance, Minimization, AND COMPENSATION Measures

BIO-18 The project owner shall implement the following measures to avoid and offset impacts to burrowing owls:

1. Pre-Construction Surveys. Concurrent with desert tortoise clearance surveys the Designated Biologist shall conduct pre-construction surveys for burrowing owls within the project site and along all linear facilities in accordance with CDFG guidelines (CBOC 1993). Pre-construction surveys for burrowing owls shall occur no more than 30 days prior to initiation of ground disturbance or site mobilization activities. The survey area shall include the Project Disturbance Area and surrounding 500 foot survey buffer where access is legally available.

2. Implement Avoidance Measures. If an active burrowing owl burrow is detected within 500 feet from the Project Disturbance Area the following avoidance and minimization measures shall be implemented:

    a. Establish Non-Disturbance Buffer. Fencing shall be installed at a 250-foot radius from the occupied burrow to create a non-disturbance buffer around the burrow. The non-disturbance buffer and fence line may be reduced to 160 feet if all Project-related activities that might disturb burrowing owls would be conducted during the non-breeding season (September 1st through January 31st). Signs shall be posted in English and Spanish at the fence line indicating no entry or disturbance is permitted within the fenced buffer.

    b. Monitoring: If construction activities would occur within 500 feet of the occupied burrow during the nesting season (February 1 – August 31st) the Designated Biologist or Biological Monitor shall monitor to determine if these activities have potential to adversely affect nesting efforts, and shall implement measures to minimize or avoid such disturbance.

3. Passive Relocation of Burrowing Owls. If pre-construction surveys indicate the presence of burrowing owls within the Project Disturbance Area (the Project Disturbance Area means all lands disturbed in the construction and operation of the PHPP Project), the Project owner shall prepare and implement a Burrowing Owl Relocation and Mitigation Plan, in addition to the avoidance measures described above. The final Burrowing Owl Relocation and Mitigation Plan shall be approved by the CPM, in consultation with USFWS and CDFG, and shall:

    a. Identify and describe suitable relocation sites on the project site or within 1 mile of the Project Disturbance Area, and describe measures to ensure that burrow installation or improvements would not affect sensitive species habitat or existing burrowing owl colonies in the relocation area;

b. Provide guidelines for creation or enhancement of at least two natural or artificial burrows per relocated owl, including a discussion of timing of burrow improvements, specific location of burrow installation, and burrow design. Design of the artificial burrows shall be consistent with CDFG guidelines (CDFG 1995) and shall be approved by the CPM in consultation with CDFG and USFWS;

c. Passive relocation sites shall be in areas of suitable habitat for burrowing owl nesting, and be characterized by minimal human disturbance and access. Relative cover of non-native plants within the proposed relocation sites shall not exceed the relative cover of non-native plants in the adjacent habitats;

d. Provide detailed methods and guidance for passive relocation of burrowing owls occurring within the Project Disturbance Area; and

4. Acquire Compensatory Mitigation Lands for Burrowing Owls. The following measures for compensatory mitigation shall apply only if burrowing owls are detected within the Project Disturbance Area. The Project owner shall acquire, in fee or in easement, 19.5 acres of land for each burrowing owl that is displaced by construction of the Project. This compensation acreage of 19.5 acres per single bird or pair of nesting owls assumes that there is no evidence that the compensation lands are occupied by burrowing owls. If burrowing owls are observed to occupy the compensation lands, then only 9.75 acres per single bird or pair is required, per CDFG (1995) guidelines. If the compensation lands are contiguous to currently occupied habitat, then the replacement ratio will be 13.0 acres per pair or single bird. The Project owner shall provide funding for the enhancement and long-term management of these compensation lands. The acquisition and management of the compensation lands may be delegated by written agreement to CDFG or to a third party, such as a non-governmental organization dedicated to habitat conservation, subject to approval by the CPM, in consultation with CDFG and USFWS prior to land acquisition or management activities. Additional funds shall be based on the adjusted market value of compensation lands at the time of construction to acquire and manage habitat. In lieu of acquiring lands itself, the Project owner may satisfy the requirements of this condition by depositing funds into the Renewable Energy Action Team (REAT) Account established with the National Fish and Wildlife Foundation (NFWF), as described in Section 3.i. of Condition of Certification **BIO-20**.

a. Criteria for Burrowing Owl Mitigation Lands. The terms and conditions of this acquisition or easement shall be as described in Paragraph 1 of **BIO-20** [Mohave ground squirrel Compensatory Mitigation], with the additional criteria to include: 1) the mitigation land must provide suitable habitat for burrowing owls, and 2) the acquisition lands must either currently support burrowing owls or be within dispersal distance from areas occupied by burrowing owls ~~from an active burrowing owl nesting territory~~ (generally approximately 5 miles). The burrowing owl mitigation lands may be included with the Mohave ground squirrel mitigation lands ONLY if these two burrowing owl criteria are met. If the burrowing owl mitigation land is separate from the acquisition required for Mohave ground squirrel compensation lands, the Project owner shall fulfill the requirements described below in this condition.

b. Security. If burrowing owl mitigation land is separate from the acreage required for Mohave ground squirrel compensation lands the Project owner or an approved third party shall complete acquisition of the proposed compensation lands prior to initiating ground-disturbing Project activities. Alternatively, financial assurance can be provided by the Project owner to the CPM with copies of the document(s) to CDFG and the USFWS, to guarantee that an adequate level of funding is available to implement the mitigation measure described in this condition. These funds shall be used solely for implementation of the measures associated with the Project. Financial assurance can be provided to the CPM in the form of an irrevocable letter of credit, a pledged savings account or another form of security ("Security") prior to initiating ground-disturbing Project activities. Prior to submittal to the CPM, the Security shall be approved by the CPM, in consultation with CDFG and the USFWS to ensure funding. The estimated costs of enhancement and endowment (see subsection, Mohave ground squirrel, for a discussion of the assumptions used in calculating the Security, which are based on an estimate of $15,169 per acre to fund acquisition, enhancement, and long-term management). The final amount due will be determined by the PAR analysis conducted pursuant to **BIO-17**.

Verification: If pre-construction surveys detect burrowing owls within 500 feet of proposed construction activities, the Designated Biologist shall provide to the CPM, CDFG and USFWS documentation indicating that non-disturbance buffer fencing has been installed at least 10 days prior to the start of any construction-related ground disturbance activities. The Project owner shall report monthly to the CPM, CDFG, and USFWS for the duration of construction on the implementation of burrowing owl avoidance and minimization measures. Within 30 days after completion of construction the Project owner shall provide to the CPM, CDFG and USFWS a written construction termination report identifying how mitigation measures described in the plan have been completed.

If pre-construction surveys detect burrowing owls within the Project Disturbance Area, the Project owner shall notify the CPM, CDFG and USFWS no less than 10 days of completing the surveys that a relocation of owls is necessary. The Project owner shall do all of the following if relocation of one or more burrowing owls is required:

a. Within 30 days of completion of the burrowing owl pre-construction surveys, submit to the CPM, CDFG and USFWS a Burrowing Owl Relocation and Mitigation Plan.

b. No less than 90 days prior to acquisition of the burrowing owl compensation lands, the Project owner, or an approved third party, shall submit a formal acquisition proposal to the CPM, CDFG, and USFWS describing the parcel intended for purchase. At the same time the Project owner shall submit a PAR or PAR-like analysis for the parcels for review and approval by the CPM, CDFG and USFWS.

c. Within 90 days of the land or easement purchase, as determined by the date on the title, the Project owner shall provide the CPM with a management plan for review and approval, in consultation with CDFG and USFWS, for the compensation lands and associated fund

d. No later than 30 days prior to the start of construction-related ground disturbing activities, the Project owner shall provide written verification of Security in accordance with this condition of certification.

e. No later than 18 months after the start of construction-related ground disturbance activities, the Project owner shall provide written verification to the CPM, CDFG and USFWS that the compensation lands or conservation easements have been acquired and recorded in favor of the approved recipient.

f. On January 31st of each year following construction for a period of five years, the Designated Biologist shall provide a report to the CPM, USFWS, and CDFG that describes the results of monitoring and management of the burrowing owl relocation area. The annual report shall provide an assessment of the status of the relocation area with respect to burrow function and weed infestation, and shall include recommendations for actions the following year for maintaining the burrows as functional burrowing owl nesting sites and minimizing the occurrence of weeds.

HAZ-9 The project owner shall prepare a site-specific Security Plan for the operational phase and shall submit it to the CPM for review and approval. The project owner shall implement site security measures addressing physical site security and hazardous materials storage. The level of security to be implemented shall not be less than that described as below (as per NERC 2002).

The Operation Security Plan shall include the following:

1. Permanent full perimeter fence or wall, at least eight feet high around the Power Block and Solar Field and meet the requirements specified in Condition of Certification BIO-11.
2. Main entrance security gate, either hand operable or motorized;
3. Evacuation procedures;
4. Protocol for contacting law enforcement and the CPM in the event of suspicious activity or emergency;
5. Written standard procedures for employees, contractors and vendors when encountering suspicious objects or packages on-site or off-site;
6.
   a. A statement (refer to sample, attachment “A”) signed by the project owner certifying that background investigations have been conducted on all project personnel. Background investigations shall be restricted to ascertain the accuracy of employee identity and employment history, and shall be conducted in accordance with state and federal law regarding security and privacy;
   b. A statement(s) (refer to sample, attachment “B”) signed by the contractor or authorized representative(s) for any permanent contractors or other technical contractors (as determined by the CPM after consultation with the project owner) that are present at any time on the site to repair, maintain, investigate, or conduct any other technical duties involving critical components (as determined by the CPM after consultation with the project owner) certifying that background investigations have been conducted on contractor personnel that visit the project site.

7. Site access controls for employees, contractors, vendors, and visitors;
8. A statement(s) (refer to sample, attachment "C") signed by the owners or authorized representative of Therminol, hydrogen, 93% sulfuric acid, and aqueous ammonia transport vendors certifying that they have prepared and implemented security plans in conformity with 49 CFR 172.802, and that they have conducted employee background investigations in accordance with 49 CFR Part 1572, subparts A and B;
9. Closed Circuit TV (CCTV) monitoring system able to pan, tilt, and zoom (PTZ), recordable, and viewable in the power plant control room and security station (if separate from the control room) providing a view of the main entrance gate, the entrance to the control room, and the ammonia storage tank but angled and physically restricted so as to not view or record any activity at Air Force Plant 42; and
10. Additional measures to ensure adequate perimeter security consisting of either:
    a. Security guard(s) present 24 hours per day, seven days per week, or
    b. Power plant personnel on-site 24 hours per day, seven days per week and:
        1) The northern and ~~eastern~~ <u>western</u> sections of the perimeter fence around the solar array shall be viewable by the CCTV system; or
        2) have perimeter breach detectors <u>or</u> on-site motion detectors for all fence lines.

The project owner shall fully implement the security plans and obtain CPM approval of any substantive modifications to the security plans. The CPM may authorize modifications to these measures, or may require additional measures, such as protective barriers for critical power pant components (e.g., transformers, gas lines, compressors, etc.) depending on circumstances unique to the facility or in response to industry-related standards, security concerns, or additional guidance provided by the U.S. Department of Homeland Security, the U.S. Department of Energy, or the North American Electrical Reliability Council, after consultation with appropriate law enforcement agencies and the applicant.

<u>Verification:</u> At least 30 days prior to the initial receipt of hazardous materials on-site, the project owner shall notify the CPM that a site-specific Operations Site Security Plan is available for review and approval. In the Annual Compliance Report, the project owner shall include a statement that all current project employee and appropriate contractor background investigations have been performed, and updated certification statements are appended to the Operations Security Plan. In the Annual Compliance Report, the project owner shall include a statement that the Operations Security Plan includes all current hazardous materials transport vendor certifications for security plans and employee background investigations.

TRANS-1 The project owner shall prepare and implement a construction traffic control plan. The traffic control plan must include but not be limited to the following issues:

- Prepare and distribute a map of the route for construction workers to use to access the proposed project site (SR-14 <u>and Sierra Highway</u> to Avenue M to the PHPP site;
- Make improvements to East Avenue M (e.g. turn and acceleration/deceleration lanes) consistent with existing project access features to allow for safe

arrival/departure to/from the project site;

- Limit heavy equipment and building materials deliveries to between 9:30am and 3:30pm, per Palmdale General Plan Circulation Element, to minimize impacts and route truck traffic around residential development;
- Provide signing, lighting, and traffic control device placement during construction impacting regional and local roadways;
- Ensure construction traffic avoids using the SR-14 on and off-ramps to East Avenue M and the intersection of Sierra Highway and East Avenue M during peak morning and afternoon traffic periods;
- Traffic diversion plans (in coordination with the cities of Palmdale and Lancaster) to ensure access during temporary lane/road closures;
- Ensure of access for emergency vehicles to the project site;
- Ensurance of pedestrian and bicycle safety from construction vehicle travel routes and any construction-related temporary travel lane closures or disruptions;
- Temporary closure of travel lanes or disruptions to street segments and intersections during reconductoring activities or any other utility tie- ins;
- Establish a parking plan for workers, construction vehicles, and trucks during transmission line and pipeline construction;
- Installation of the natural gas pipeline and water line to occur during non-peak hours; and
- Use flagging, flag men, signage and cover open trenches when needed.

Verification: At least 90 days prior to the start of site mobilization, the project owner shall submit a traffic control plan that outlines each component above to Caltrans and the cities of Palmdale and Lancaster Planning Departments for review and comment and to the CPM for review and approval. The project owner shall provide the CPM with any comments from Caltrans and the cities of Palmdale and Lancaster.

TRANS-8 Prior to the start of construction, the project owner shall provide a plan to the CPM and the Air Force Plant 42 Commander identifying all reasonable measures the project owner will take to minimize the creation of glint and glare on Air Force Plant 42 airfield traffic including, but not limited to, the following:

1. Ensure the mirrors are (1) brought out of stowage before sunrise and are aligned to catch the first rays of the morning sun; and (2) returned to stow position after sunset. Ensure mirrors are continuously monitored for malfunctions and remain properly aligned with the sun.~~ ~~Acquire appropriate equipment and establish procedures ~~to cover inoperative or malfunctioning mirrors immediately after malfunctions are discovered to prevent the escape of errant reflections.~~ <u>for a timely repositioning of inoperative or malfunctioning mirrors to minimize the probability of glint or glare exposure. Procedures shall address the mirror trajectory path to a stowage position, or</u>

in the event that stowage is not possible, an alternate trajectory to a neutral positioning with respect to glare. Mirror repositioning due to a mirror alignment malfunction shall be accomplished as soon as practical to minimize glint or glare exposure.

2. Minimize reflections from bellows shields by using a non-reflective or diffuse material or coating (for example, paint) for the shields.

3. Ensure PHPP operator establishes and maintains a communication link with Air Force Plant 42 control tower to ensure that ~~when necessary~~ mirrors are positioned so as not to interfere with critical flight operations.

4. Establish procedures to avoid glare when intentionally moving individual collectors off-axis to “dump” power incident on the heat collection elements during periods of high insolation.

~~If the plant operator needs to dump power and rotate several modules off-axis, the operator shall start with the modules at the north-most and west-most parts of the collector field, which is furthest from the Air Force Plant 42 to the southeast. For each module that is rotated off-axis, the operator shall consider the nearest flight pattern; if it is to the east, then the module shall be rotated to the west, and vice-versa. This rotating shall be done in a manner that minimizes the impact of glare on aircraft (for example, rotating modules furthest from the airport in a direction that is away from flight patterns).~~ The plant operator shall develop and implement a plan to address events in which mirror modules need to be rotated off-axis, such as an event in which it is necessary to dump power. The mirrors’ rotational trajectory and final positioning shall ensure the safe movement and positioning of the mirror modules with respect to operational flight patterns to minimize the occurrence and impact of glint or glare events.

In addition, this plan shall include specific provisions for tracking and compiling data involving any and all mirror malfunctions. This data shall include the (1) date, time and location of offending mirror or mirrors; (2) specific adjustments made to correct each mirror or mirrors; (3) date and time specific adjustments were evaluated for effectiveness; and (4) effectiveness of each adjustment. That information shall be included in the monthly compliance reports during construction and in the semi-annual compliance reports during operation. This information will be used to ensure that the offending mirrors are quickly adjusted, thereby having a minimum impact on flight operations. In addition, this information will provide data for the plant operator to use in monitoring mirror operations and preventing malfunctions.

Verification: Within 30 days prior to the start of construction, the project owner shallsubmit the required plan to the Air Force Plant 42 Commander for comment and to the CPM for review and approval. The project owner shall also notify the CPM when the required modifications have been made and are available for inspection.

In addition, the project owner shall include in the monthly compliance reports all data concerning malfunctions of any mirrors during construction and initial start-up operation of the plant and in the semi-annual compliance reports during regular operation.

WASTE-2 In areas where the land has been or is currently being farmed, and where excavation or significant ground disturbance will occur for the construction of the project transmission line, soil samples shall be collected and tested for herbicides, pesticides, and fumigants to determine the presence and extent of any material levels of contamination.

The sampling and testing plan shall be prepared in consultation with the appropriate Los Angeles County agency, conducted by an appropriate California licensed professional, and sent to a California Certified laboratory for testing. Sampling and analysis shall be consistent with the DTSC's 'Interim Guidance for Sampling Agricultural Properties ~~Fields for School Sites~~ (Third Revision)' or equivalent. A report documenting the areas proposed for sampling, and the process used for sampling and testing shall be submitted to the Energy Commission for review and approval at least 90 days before transmission line construction occurs in the affected areas. Results of the laboratory testing and recommended resolutions for handling and excavation of material found to exceed regulatory requirements shall be submitted to the Energy Commission 60 days prior to transmission line construction occurs in the affected areas. Should sampling indicate additional remediation or mitigation is required, Conditions of Certification **WASTE-3** and **-4** would apply.

Excavated materials containing elevated levels of pesticide or herbicide require special handling and disposal according to procedures established by the regulatory agencies. Effective dust suppression procedures shall be used in construction areas to reduce airborne emissions of these contaminants and reduce the risk of exposure to workers and the public. Regulatory agencies for the State of California and Los Angeles County shall be contacted by Applicant or its contractor to plan handling, treatment, and/or disposal options.

Verification: The project owner shall identify the current/previous land use for the project transmission tower locations and associated laydown and staging areas for construction of the transmission line. The project owner shall submit a report documenting the areas proposed for sampling, and the process used for sampling and testing to the CPM for approval at least 90 days before transmission line construction occurs in the affected areas. Results of the laboratory testing and recommended mitigation or remediation plan for handling and excavation of material found to exceed regulatory requirements shall be submitted to the CPM for review and approval 60 days prior to transmission line construction.

ADDENDUM TO STAFF'S REBUTTAL TESTIMONY

Visual Resources

Testimony of James Adams

Road paving activities can be seen by local residents or motorists who live or work near the roadways identified above. These visual impacts are temporary in nature (couple to several days) as work crews pave one section of road and move on. In this case, the road segments are located in rural areas within the city of Palmdale or in unincorporated Los Angeles County. The roads are lightly traveled in sparsely populated areas and several are fairly short in length. Therefore, staff believes that visual impacts from the proposed road paving activities would be less than significant and would not warrant visual resources mitigation.

DECLARATION OF
James Adams

I, James Adams declare as follows:

1. I am presently employed by the California Energy Commission in the Environmental Office of the Siting, Transmission, and Environmental Protection Division as a Planner II.

2. I prepared staff testimony related to Traffic and Transportation and Visual Resources impacts for road paving for the Rebuttal Testimony for the Palmdale Hybrid Power Project (08-AFC-9) based on my independent analysis of the Application for Certification and supplements hereto, data from reliable documents and sources, and my professional experience and knowledge.

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge and belief.

Dated: 1/19/11 Signed: ______________

At: Sacramento, California

DECLARATION OF
Gregg Irvin, Ph.D.

I, Gregg Irvin declare as follows:

1. I am presently employed by the California Energy Commission as a consultant in issues pertaining to vision science.

2. A copy of my professional qualifications and experience is attached hereto and incorporated by reference herein.

3. I prepared staff testimony for the Traffic and Transportation section with respect to an Independent glare assessment for the Palmdale Hybrid Power Power Plant project based on my independent analysis of the Application for Certification and supplements hereto, data from reliable documents and sources, and my professional experience and knowledge.

4. It is my professional opinion that the prepared testimony is valid and accurate with respect to the issue addressed herein.

5. I am personally familiar with the facts and conclusions related in the testimony and if called as a witness could testify competently hereto.

   I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge and belief.

Dated: 1/26/11 Signed: Gregg Irvin

At: Dayton, Ohio

GREGG E. IRVIN, PH.D.
3731 Blossom Heath Road
Dayton, OH 45419
937-271-2715

EMPLOYMENT

2005-Present	President, Spectrus, Ltd.
1996-2005	Principal Partner and Director of Operations, Mobium Enterprises, Inc.
1994-1997	Executive Director, Assistive Technologies Group
1996-2000	Employee Consultant, National Security Studies and Strategies Group, Science Applications International Corporation (SAIC), McLean, VA.
1993-1996	Assistant Vice President, SAIC, Dayton, OH.
1995-1996	Division Manager, Human Systems Technology Division, SAIC
1992-1995	Division Manager, Aerospace Systems Division, SAIC
1990-1991	Chief Scientist, Human Performance Technology Division, SAIC
1989-1990	Senior Scientist, Human Performance Technology Division, SAIC
1986-2000	Director, ICON Consultants, Birmingham, AL & Dayton, OH.
1985-1989	Senior Research Scientist, Systems Research Laboratories, Dayton, Ohio.
1984-1985	Visual Neurophysiologist, Vision Science Research Center, University of Alabama Medical School at Birmingham.

EDUCATION

1982-1984	National Eye Institute, Postdoctoral Fellow, Electrophysiology, Vision Science Research Center, School of Optometry, University of Alabama Medical School at Birmingham.
1981-1982	Postdoctoral Research Associate, Visual Neurophysiology, Department of Physiological Optics, School of Optometry, University of Alabama Medical School at Birmingham.
1981	Ph.D. Physiological Psychology, Syracuse University.
1976	B.A. Psychology, Syracuse University.

AWARDS/FELLOWSHIPS/DISTINCTIONS

1995-2003	Adjunct Faculty, Department of Biomedical and Human Factors Engineering, Wright State University, Dayton, OH.
1982-1984	National Eye Institute, Individual National Research Service Award
1979	Behavioral Neurobiology Scholarship, Cold Spring Harbor Research Laboratory, Syracuse University School of Engineering, Institute for Sensory Research.
1978-1980	Graduate Fellowships in Biopsychology (two awards), Syracuse University.
1977-1978	Graduate Fellowship in Physiological Psychology, Syracuse University.
1976-1977	Research Associate, Visual Psychophysics Laboratory, Syracuse University.

PROFESSIONAL SUMMARY

Dr. Irvin is a sensory psychologist with a multidisciplinary background in visual science related fields including; applied experimental psychology, sensory perception, visual physiology and psychophysics, advanced image processing, human information processing, human perception and performance, mathematical visualization, neurobiology and human factors engineering. Dr. Irvin's focus is on applied technology development and has 25 years of experience in laser exposure effects and laser hardening technologies.

Dr. Irvin is president of Spectrus, Ltd. Spectrus is a diversified small business providing services in engineering, human factors, neuroscience, physics, chemistry and life sciences. Spectrus develops advanced sensing technologies for indirect view multispectral and hyperspectral applications, which incorporate proprietary spectral mapping principles and (active and passive) frequency agile sensing capabilities. Spectrus also provides sensory modeling, image understanding, specialized spectral sampling applications, advanced Human-System Interface development, and multidisciplinary sensing strategy services.

Dr. Irvin has strong leadership and managerial skills with a record of success in leading major research and development programs. This includes Air Force Research Laboratory programs developing physiologically based computer vision systems (stereovision, detection, and texture generation), laser eye and sensor protection, laser optical countermeasures, low-observable technologies, and multispectral adaptive and passive camouflage, concealment and deception technologies. Efforts include developing and interfacing both head-steerable and advanced helmet mounted displays with integrated multisensor fusion capabilities for strategic aircraft, developing imaging architectures, information visualization technologies, and display technologies incorporating specialized chromatic, motion, and texture processing. Contributions to visual science include a model of developmental amblyopia, various models of human visual detection, studies of information transfer to primate visual cortex, and structure-function studies of neuronal morphology and visual information processing. Dr. Irvin's experience and qualifications span basic and applied advanced research and development, and technology transfer and application. Dr. Irvin has been featured in National Geographic "The Sense of Sight" and in a PBS NOVA documentary "The Disguises of War."

EMPLOYMENT EXPERIENCE

Spectrus, Ltd. (2005-Present)

President, Spectrus, Ltd. is an Ohio based Limited Liability Company established in January 2005 and provides consulting services to Government and industry. Dr. Irvin is the president and sole partner in Spectrus, Ltd. Spectrus represents a reorganization of Mobium Enterprises, Inc. and Mobium, Inc., for which Dr. Irvin was the president of both.

Representative Research and Development Efforts at Spectrus:

Visor Technology Demonstration (2009-). Under the Hardened Materials Research and Survivability Studies (HMRSS) contract developing and integrating advanced laser protection technologies for visors and visor helmet mounted display systems. Efforts include identification and optical performance characterization of laser threat systems and the development of laser hardening goals via engagement modeling and simulation with airborne platforms in representative mission profiles. Supporting absorptive and reflective technology development includes modeling and performance characterization of the absorptive spectra of candidate molecular structures for chemical synthesis, and modeling and analysis of dielectric deposition processes for binocular visor protection performance, stress factors and mechanisms of haze generation. Lead for the development of laser protection designs and their performance evaluation for visors and hybrid visor-spectacle systems with various helmet mounted display systems. Lead for laboratory visual psychophysical evaluations including contrast sensitivity, visual acuity and color discrimination as well as field evaluation of usability, visual and AFE compatibility, and user acceptance.

Hardened Night Vision Goggle Program (2005-2009). As a subcontractor to GDIT designed, performance modeled and field evaluated laser hardening for NVGs. Technologies included Optical Power Limiters (OPLs), Cholesteric Liquid Crystals CLCs), Complimentary Comb Filters (CCombs), Laser Warning Receivers, and fixed filters including Out-of-Band and Flip-in. An extensive laboratory NVG test bed has been developed at AFRL/RXPJ to characterize laser exposure effect and evaluate various laser hardening technologies both in terms of their laser hardening effectiveness and impact on sensor and human-systems performance. Modeling and analysis was conducted to define candidate integrated System Level configurations capable of laser hardening NVGs against both fixed and agile laser threat systems. Several prototype Systems Level configurations were subsequently field evaluated at the WPAFB Laser Infrared Development (LID) range. The field environment provided an opportunity for mission representative levels of illumination, realistic atmospheric turbulence effects, the recording of real-world calibrated targets, and an opportunity for operator psychophysical performance assessments. The experiments conducted enabled an assessment of the laser protection levels provided by the hardening technologies and an assessment of the performance impacts of the technology without and with laser exposure.

Advanced Optical Coatings (2007-2010). Designed, performance modeled and field evaluated distributed (spectacle and visor) laser eye protection for the F-35 Joint Strike Fighter. The Advanced Optical Coatings Monolithic Demonstration (AOC Mono Demo) was a design and manufacturing demonstration for a monolithic (non-laminated) LEP spectacle. Additionally, the AOC Mono Demo addressed the LEP design requirements for the F-35 Joint Strike Fighter. Due to visual compatibility issues with the JSF Helmet Mounted Display System (HMDS) the LEP solution required a hybrid approach in which the LEP is split between the spectacle and a visor. A variety of spectacle and visor designs were developed, manufactured, characterized, and both lab and field evaluated.

All-Dye Daytime Army LEP Spectacle Demonstration (2009). This Demonstration represented the first design and prototype manufacturing initiative for an all-dye spectacle which integrated a new visible dye, TBAF-1, into the laser hardening solution space. The laser hardening and visual performance requirements for an Army LEP acquisition were adopted as the demonstration challenge. An optimized all-dye design was developed for a daytime application and was successfully manufactured and evaluated. The demonstration was successful as a prototype manufacturing initiative for an all-dye spectacle which integrated the new TBAF-1dye into the laser hardening solution space.

Air Force Laser Eye Protection (ALEP) Block 2 System Design and Development (SDD) Program (2007-2009)**.** As a subcontractor to Teledyne Scientific & Imaging Systems, Teledyne Imaging Sensors (TIS) Spectrus provided support for the design, characterization and evaluation of various candidate ALEP systems. Work efforts included: a) analytic and design support for the definition of ALEP spectral profiles to meet the SRD thresholds/objectives, b) support for ALEP risk identification, assessment and prioritization, and c) support for ALEP cost/performance trade-offs and the manufacture and testing of ALEP. Spectrus also provides support for human performance evaluations and in-cockpit field evaluations. This includes psychophysical data collection for visual acuity, contrast sensitivity and color discrimination assessments, the development of human visual performance testing and evaluation procedures, and supportive modeling of the ALEP devices for human performance modeling of detection/ recognition/ identification of targets.

Joint Strike Fighter (JSF) Laser Eye Protection System Development Program As a subcontractor to TIS Spectrus provided quick response support for the design, development, characterization and analysis of laser eye protection systems in support of the JSF Laser Eye Protection System Development Program Phase 1 development through Preliminary Design Review. The primary JSF program challenge was the provision of a cost effective integrated LEP system which maintained compatibility with the JSF Helmet Mounted Display System (HMDS). The JSF HMDS is a 30° x 50° wide-field-of-view binocular display system providing the pilot with weapons/sensor video overlaid with symbology. The HMD provides an integrated day/night capability with sensor fusion. The JSF helmet system serves as the 'virtual HUD' in the F-35, which is the first modern tactical aircraft designed without a conventional Head-Up Display (HUD). Spectrus provided expertise to investigate and apply the principles of visual science and multidimensional optimization techniques to the design of JSF laser protective eyewear systems. Filter design methodologies are applied which consider the conjoint optimization of: a) reflective and absorptive JSF component technologies, and b) competing requirements for visual compatibility, laser hardening, and materials and manufacturing in the context of mission requirements. Under development are JSF-LEP prototype systems for PDR which consist of both a visor (coupon) and spectacle (ophthalmic lenses) components.

JCAS: JHMCS Compatible Aircrew Laser Eye Protection (ALEP) Rapid Response Program. Spectrus provided support to the Rockwell Science Center (Rapid Response Phase) and provides support to Teledyne Imaging Sensors (Phase 2) for design optimization and performance characterization of a JCAS LEP system. JCAS is a ‘spin-off’ of the original ALEP Block 1 SDD program intended to solve the problem of providing LEP physically compatible with the JHMCS visor system. Spectrus provides analytic and design support for the definition of JCAS spectral profiles to best meet the Block-1 performance specifications with reasonable trade-offs to achieve a CDR LEP system design that is both physically and visually compatible with the JHMCS. Support is also provided for field evaluations of prototype LEP.

Visor Laser Eye Protection Design Initiative for Integrated Spectacle-Visor LEP Solutions Program Manager under the Materials and Processes for Personnel Protection research initiative (AFRL/RXPJ). Although the US military has engaged in a variety of visor laser hardening programs and spectacle laser hardening programs, there has been no systematic investigation of hybrid spectacle-visor LEP system designs that distribute laser hardening across both the spectacle eyewear and helmet visor. This short term initiative explored the utility of hybrid spectacle-visor LEP systems for a variety of design configurations with a variety of laser hardening requirements, including the ALEP Block 2 SDD program. Integrated designs were evaluated and characterized for their predicted performance both as stand alone devices and as an integrated system. The design trade space included the competing trade space between the population of laser hardening requirements and the population of visual performance and visual compatibility metrics. Various requirements were manipulated as appropriate, to ascertain the most viable integrated solutions that satisfied the all competing constraints for protection, visual compatibility, manufacturability, and life cycle cost.

Advanced Hardening Technologies. Program Manager under the Materials and Processes for Personnel Protection research initiative to investigate and develop materials technologies that, singly or in combination, provide jamming and damage protection for USAF assets against friendly/hostile lasers operating in the Visible and Near Infrared (VIS/NIR) spectral regions.

Efforts include: 1) Implementing a research initiative to investigate the utility of implementing a state-of-the-art multi-sensor CCD indirect view Helmet Mounted Display (HMD) optical system capable of display representations of the external scene in which an attempt is made to best offset the inherent limitations (as applicable to human-system performance) of the specific technology implementation by integrating recent advances in multi-spectral information processing theory to provide the operator with information enhanced representations based on advanced real-time multi-spectral image processing techniques. A laboratory prototype system will be developed to demonstrate the utility of the approach and explore the sensor/algorithm/display technology implementations that provide the best solution options to minimize the impact of frequency agile threat laser systems while concurrently maximizing relevant operational human-systems performance. 2) Threat Assessment, Engagement Modeling and Requirements Definition to include an indirect view helmet mounted display system based on binocular off-board sensors (CCD-based) which extend the sensing spectral envelope beyond that of direct view systems in the requirements definition process, and the development of appropriate experimental conditions and definition of the experimental design for the supporting engagement modeling analyses, 3) Laboratory and Field Assessments of Prototype Devices to include the conduct of field measurements to characterize the emissive and reflective spectral environments for various fighter aircraft, transport aircraft, and helicopters as required.

3-CCD Laser Hardening Program. The goal of the 3-CCD Laser Hardening Program is to develop a customized 3-CCD sensor system for which laser jamming and damage effects can be mitigated and/or eliminated. At the core of the hardened sensor system is a prism assembly designed to split the visible spectrum into three distinct spectral bands while incorporating both in-band and out-of-band laser hardening. Spectrus is providing support to this program by a) defining optimized spectral bands to avoid known laser threats while maintaining maximum sensor sensitivity and image quality, b) maximizing environmental information extraction under laser exposure by concurrently optimizing all two-band sensor fusion strategies, c) developing information and image quality metrics, d) developing design and integration strategies for the subsequent insertion of frequency agile filters and optical limiters into each spectral band. The program goal is to combine all laser hardening components into a demonstration 3-CCD hardening device with in-band and out-of-band laser rejection filters, agile filters and limiters in each spectral window, and software control to provide high quality imaging during and after laser engagement.

Department of Homeland Security Program. Provided support to the Department of Homeland Security, and US Secret Service (Special Services Division, Technology Services Division, and the Presidential and Vice Presidential Services Divisions) for the measurement and characterization of specific high value assets, the subsequent analysis of laser protection requirements, and a technology implementation plan.

Joint Helmet Mounted Cueing Systems (JHMCS) Program. Program Manager. This 3 month effort supported Rockwell Collins, Kaiser Electronics for the provision of all-dye laser hardened JHMCS visor designs, prototype visor manufacture and the conduct of analysis and characterization studies. The Joint Helmet Mounted Cueing System (JHMCS) is a monocular 20° field-of-view helmet display with an integrated day camera and dichoptic cursors for extended up-look capability. JHMCS enables the pilot to accurately direct (cue) onboard weapons, including High-Off-Boresight (HOBS) missiles, against enemy aircraft while performing high-G maneuvers day or night. As a cueing system, JHMCS is a two-way interface; sensors aboard the aircraft can cue the pilot to potential targets or, conversely, the pilot can cue weapons and sensor systems to areas of interest. Critical information and symbology such as targeting cues and aircraft performance parameters are graphically displayed directly on the pilot's visor. Spectrus developed a variety of all-dye visor LEP designs, supported the prototype manufacture, and provided all metrics characterization and predicted performance analysis. Currently JHMCS is in full rate production and a combat-proven force multiplier fielded on multiple front-line fighter / attack aircraft. With over 900 systems delivered, JHMCS is operated by several air forces worldwide on F-15, F-16 and F/A-18 aircraft.

Mobium Enterprises, Inc. (1996-2005)

Principal partner, Director of Operations of Mobium Enterprises, Inc. Mobium is an Ohio C Corporation headquartered in Dayton, with offices in Alabama, Colorado, Massachusetts and New York. Mobium is active on local, state and national levels promoting strategic alliances between and among academe, industry, and government for the development of seminal technologies to enhance human perception and performance. Mobium seeks to reveal broader markets for the commercialization of human-systems technologies by emphasizing common needs and by emphasizing flexible modular technology that can be adapted to meet a variety of needs. Mobium is actively involved in a variety of joint technology development.

Mobiums' commercialization ventures include: a) a patented and licensed fluid jet array technology to reduce fluid precursor requirements to prepare thin films in semiconductor manufacturing, b) a differential ultra-violet filter technology (patent pending) for fabrication into optical filters using liquid and polymeric hosts, c) SWIFT – Stored Waveform Inverse Fourier Transform software package for the design of gradient index optical filters (patent in process), d) a plasma based ultra-thin film corrosion-inhibiting primer coating technology for stainless steel and aluminum to replace toxic chromium primer techniques (joint development venture in process). Additionally, Mobium is engaged in a software development project entitled MathWeb™. MathWeb™ is a Java-based tensor analysis and display package that is designed to run on distributed and heterogeneous networks and parallel computers.

Mobium provides expertise in advanced optical design and the analysis of multispectral imagery. Principals of Mobium have served as consultants to the U.S. Air Force on topics involving advanced human-system interfaces, and the protection of human and other optical sensors from laser damage. These projects include development of gradient index (rugate) optical filter designs, plasma-enhanced chemical vapor deposition of organic nonlinear optical materials, laser-hardening of night-vision equipment, and development of spectral embedding methods for indirect view sensor systems. Mobium personnel also have designed camouflage for the U.S. and European Armies and are aware of a broad range of programs sponsored by the DoD, NASA, DARPA, and other agencies concerned with the acquisition and interpretation of multispectral imagery. Mobium has developed a suite of sequential algorithms for enhancing the visualization and display of complex data sets and has examined the human factors that constrain the performance of integrated sensor suites in Uninhabited Aerial Vehicles.

Dr. Irvin's focus within Mobium is on the development of advanced sensing capabilities to facilitate human perception and performance. Dr. Irvin specializes in information extraction and enhancement through the application of advanced spectral sampling methodologies and the subsequent information transformation and representation for specialized human-in-the-loop applications.

Representative Research and Development Efforts at Mobium:

Night Vision Goggle (NVG) Hardening Research and Development and Testing
Project Manager. This three-year effort supports the Wright Laboratory, Materials Directorate (WL/MLPJ) Laser Hardened Materials Advanced Studies contract. The objective is to develop NVG hardening methods for integration into existing or emerging NVG systems and to test individual hardening components and the integrated hardened system. The program tasks include the development of hardening filters, the development of sensor damage and jamming models, and engagement modeling. The hardening concepts are designed and evaluated in the context of realistic mission and engagement scenarios to define critical metrics such as accessibility of the threat, probability and duration of exposure, energy incident at the sensor, and, given relevant angular performance characteristics, the probability distributions of energy incident.

Laser Eye Protection (LEP) and Night Vision Imaging Systems (NVIS) Design, Analysis and Measurement Support. Project Manager. This 2-year effort supports the Wright Laboratory, Materials Directorate (WL/MLPJ) Laser Hardened Materials Advanced Studies contract. Support is provided for the Advanced Technology Demonstration (ATD) programs for the design, analysis, prototyping and evaluation of LEP and Night Vision Goggle (NVG) filters. Analysis and design support is provided for the acquisition and manufacture of filters for a concept demonstration for the use of NVGs in daytime operations and includes the development of instrumentation and measurement techniques for in-cockpit NVIS spectral characterization and measurement. The efforts include the design and prototyping of an 'ideal' tristimulus filter based on minimum spectral footprint and the optimum integration of dye/dielectric/rugate components. Additionally, a flight engagement model was developed for Aircrew Laser Eye Protection Performance Characterization to Laser Threat Systems in Representative Operational Mission Environments. The objective of this effort was to provide a relevant modeling/simulation application to support the verification and characterization of laser threat protection requirements using representative flight profiles in operational mission contexts.

Air Force Laser Eye Protection ALEP Block 1 Programs. Project Manager for subcontracts to both the Rockwell Scientific Company LLC and Kaiser Optical Systems, Inc. for two successive Aircrew Laser Eye Protection (ALEP) programs, the Program Definition and Risk Reduction (PDRR) program and the System Design and Development (SDD) Program for the Air Force 311th Human Systems Program Office (Brooks AFB, TX). The objective of the Aircrew Laser Eye Protection (ALEP) program is to develop, manufacture, field and sustain a system that will provide Air Force aircrew members protection against laser devices/systems in combat, military operations other than war, and training situations while minimizing visual performance degradation. Aircrews will employ the ALEP whenever laser devices (e.g., rangefinders and designators) are likely to be employed by US, Allied, or unfriendly forces. ALEP will protect against invisible wavelength weapons. Mobium provides ALEP design and analysis support.

Spectral Embedding Methodologies. Project Manager. This 3-year effort supports the Wright Laboratory, Materials Directorate (WL/MLPJ) Laser Hardened Materials Advanced Studies contract to develop and apply Spectral Embedding Methodologies (SEM) to laser hardening applications. The applications to be investigated include direct viewing by an observer through a spectrally selective filtering system, and indirect viewing of displayed sensor outputs of night vision sensing systems. The goal is to develop and apply effective laser hardening methodologies, which demonstrate potential for compensating for information losses and enhancing overall human-system performance and mission effectiveness. The SEM program investigates and considers broadly both sensing and display methods. The sensing methods require: 1) defining the information content of the operational environment in the spectral region of a particular sensing system, 2) development of selective spectral sampling paradigms which concurrently provide effective laser hardening and task/mission relevant information sampling, and 3) sampling methods and/or image processing algorithms to efficiently represent relevant information content. The display methods require: 1) characterization of the human constraints on visual information processing, 2) development of filtering strategies and/or multi-band image processing algorithms to provide an "information bandwidth match" to the human visual system, and 3) the implementation of appropriate display algorithms to maximize human perception and performance

Aircrew Laser Protection Concept Design and Evaluation Support. Project Manager. This effort provides support to the Wright Laboratory, Materials Directorate (WL/MLP) Materials Processing Technology Initiative contract. Support is provided for the design, fabrication and evaluation (including field testing) of candidate laser protective eyewear using a variety of technologies including holographic, rugate, absorptive dye, dielectric stack and enhanced thin films. Design requirements are being established for protection from threat laser systems, compatibility with human visual system information processing, airframe cockpit lighting compatibility, consideration of spectral properties of the environment, consideration of aircrew acceptance, and compatibility with materials science limitations. Support is also being provided to the Affordable Technology through Integrated Process and Product Development for Science and Technology AT/IPPD/S&T Working Group and the Joint Cockpit Display Working Group.

Human-Systems Technology For Uninhabited Aerial Vehicle (UAV) Ground Stations. Provided support to Air Force Armstrong Laboratory Phase I SBIR program (AL/CF). The approach is based on a structured methodology for the development and commercialization of human-systems technology. The Technical Objectives are to: (1) identify human-systems interfaces (HSI) and virtual-reality (VR) technologies that require development to ensure the maturity necessary for a UAV VR control station or center, (2) propose a UAV VR concept demonstration supporting intelligent aiding, decision support, and mission management flexibility, and (3) identify issues and design tradeoffs involving human performance variables and VR properties.

Unmanned Combat Air Vehicle (UCAV) Program Support. Program Manager. Provided support to Raytheon E-Systems as a team member within the UCAV Ground Segment IPT to enhance the Unmanned Combat Aerial Vehicle (UCAV) IRAD project execution. Support focused on the: 1) study, analysis, identification and development of advanced Human Systems Interface (HSI) and Human Computer Interaction (HCI) functionality segmentation, 2) the inclusion of Automated Decision Aids to support HSI and HCI, and 3) analysis and identification of relevant technology domains pertinent to HSI technology insertion related to the UCAV Ground Station. Mobium provided trade study documents and support to the various Program Milestone and Technical Interchange Meetings.

Spectral Mapping of Indirect View Systems for Laser Hardening. Project Manager. This effort investigated the application of technologies and concepts developed for the laser hardening of human and machine sensors to sensor-based indirect view optical systems through the application of proprietary spectral mapping methodologies. The program demonstrated novel and emergent capabilities that greatly enhance certain mission critical aspects of human-system performance. The process incorporates physiologically relevant information processing and display techniques to develop environmentally-relevant selective spectral sampling strategies prior to sensor processing, and the subsequent mapping of derived higher order representations into physiologically-relevant display specific representations.

Integration of Absorbing Materials into Polymeric Multilayer Optical Filters for Optimized Hybrid Filter Designs. Project Manager on 3M Worldwide, 3M Film/Light Management Technology Center subcontract. This effort investigated the design of absorptive filters to be used in conjunction a with 3M proprietary reflective filter technology to produce optimized system filter sets to support visible and NIR sensing techniques over a broad range of incidence angles. A variety of performance metrics were developed and different dye processing/stability manufacturing techniques analyzed to maximally support the development of Metameric photopic luminosity equivalence over the full range of sensor angular performance.

Expert Assessment Support. Project Manager. This effort provides support to the Wright Laboratory, Materials Directorate (WL/MLP) Special Advanced Studies for Hardened Materials Program, Technology and Technology Transfer Initiative. Support is provided for the design and evaluation (theoretic, laboratory, and field testing) of passive laser protective optical media for aircrew eyewear. Optimized designs incorporate constraints based on threat, in- and out-of-cockpit compatibility, materials science capabilities and limitations, mission performance requirements, and human visual processing considerations. Additional support is provided to the *Enhanced Dyes for Laser Eye Protection* program for analysis, modeling and determination of system spectral characteristics relevant to the human visual interface.

Collaborative Commercialization, Research and Development Efforts with Syracuse University:

Dr. Irvin managed Mobium Enterprises extensive joint relationship with the Scalable Concurrent Programming (SCP) Laboratory at Syracuse University (SU) for technology development and commercialization through technology transfer. From 1999-2002 Mobium engaged in a variety of collaborative research and development programs with SU that include Distributed Real-Time Sensors Project and the Information Resiliency: Strategic Concepts for Assurance and Recovery Project. As a result of these collaborations Mobium maintained an office at the Syracuse University CASE (Computer Applications and Software Engineering) Center providing support to the SU research team on a daily basis. A brief description of the joint SU-Mobium initiatives and the resulting commercial technologies are as follows:

Distributed Real-Time Sensor Fusion. Project Manager. In a collaborative research effort with the SU-CASE center investigated the use of multiple sensors to increase the capability of intelligent system dealing with multi-sensor fusion and integration (MFI). Mobium developed distributed spectral-screening PCT algorithms for fusing hyper-spectral images in remote sensing applications. The algorithms provided intrusion tolerance from information warfare attacks using the framework of computational resiliency. Dynamically regenerative replication algorithms were integrated with replication-based fault tolerance mechanisms to respond to intrusion attacks and system failures. The utilization of application independent library technologies masked the details of communication protocols required to achieve dynamic replication and reconfiguration in distributed applications.

Computational Resiliency, Heterogeneous Reliable Applications. Project Manager. In conjunction with the Center for Systems Assurance (CSA) and the Computer Applications and Software Engineering Center at Syracuse University this initiative investigated the development of distributed computing systems to provide fault-tolerance through group communication based active replication, automatic reconfiguration and recovery from the attacks and failures, and load balancing over heterogeneous resources. The research focused on intrusion detection, high-confidence design, network security, information assurance, computer forensics, process migration, split/merge of processes, and camouflage techniques to achieve reasonable resiliency goals within defined predictive analytical models of performance assessment.

Integrated Spectral Transmission Optimization Research Model (I-STORM). I-STORM is a collection of advanced analytic tools and empirical spectral libraries for the design and characterization of hybrid optical filters. A unique aspect of I-STORM design optimization is the conjoint consideration of materials science and manufacturing limitations for both absorptive (organic dyes) and reflective (dielectric thin film) technologies. A primary I-STORM application is supporting the Air Force Laser Eye Protection, Advanced Technology Demonstration (ALEP-ATD) and Engineering Manufacturing and Demonstration (ALEP-EMD) programs at Wright-Patterson (Ohio) and Brooks (Texas) Air Force Bases, respectively. The focus of this program is the design, prototyping and manufacture of visually compatible laser protective eyewear for Air Force pilots, which preserves scene and cockpit display color and luminance. Additionally, I-STORM has been integrated into a commercial product, Optical Tool Bench TM, a beta software release package for the Windows NT operating systems.

Remote Sensing Multispectral Image Exploitation. This joint initiative involves the development of advanced parallel algorithms and display technologies to facilitate the real-time data acquisition and exploitation of multispectral image streams. The resulting technology suite, currently in the final stages of development for proof-of-concept demonstration, provides the basis for commercial products to support various terrestrial and airborne remote sensing applications (e.g., land resource management, agricultural and crop monitoring, military target identification), and medical applications (e.g., multispectral endoscopy and ophthalmology). This initiative involves the development of: a) adaptive temporal-spectral real-time multispectral image acquisition, b) optimized real-time decorrelation and compression algorithms, c) advanced human-system interface for physiologic information bandwidth optimization, and d) the development of supporting distributed and concurrent computer architectures. A multispectral image exploitation algorithm suite is currently under development to support the Spectral Embedding Methodologies R&D Program for the development of next-generation sensor hardening for direct and indirect-view airborne military optical systems.

Cyber-Eye™ Multispectral Camera Systems. A natural outgrowth of the collaboration for multispectral image exploitation was the development of a multispectral imaging camera system to support laboratory and field data acquisition. The result was the design and development of a family of high-speed digital multispectral imaging systems supported by high performance multiprocessing. The Cyber-Eye camera series includes multispectral digital imaging systems capable of real-time 12 spectral band image acquisitions and processing at 120 frames per second. The commercialization of these systems is in process. A Cyber-Eye system was developed for the Air Force to support the Spectral Embedding Methodologies program referenced above.

MathWebTM. MathWeb is a tensor-based applications development product specifically designed to support distributed concurrent and heterogeneous computing environments. This commercial product has been used in a variety of government and industry applications. One such application in the final development stages is an integrated suite of image processing tools for real-time processing of multispectral and hyperspectral sensor data, image exploitation, and unique visualization techniques for human-system interface. Both the Cyber-Eye Multispectral Camera Systems and I-STORM incorporate MathWeb as the basis operating system.

Assistive Technologies Group (1994-1996)

ATG develops consortia and strategic alliances, and serves as a technology and information broker to support biobehavioral technology transfer initiatives.

Dr. Irvin founded and served as executive director of the Assistive Technologies Group (ATG). ATG's mission is to develop and transition advanced federal technologies to a sustainable national industrial capability within the commercial market of assistive technologies for Americans with disabilities. As a not-for-profit company, ATG served to promote and participate in research on limitations to human perception and performance that are due to disabling physiological or environmental conditions, and, promote and participate in the development of technology that can restore or enhance otherwise impaired human perception and performance. ATG nurtured links between research and technology development by promoting biobehavioral research that is commensurate with engineering descriptions and specifications. ATG is active on local, state and national levels to promote strategic alliances between academe, industry and government to develop seminal technologies that can identify or ameliorate biomedical constraints on human behavior. ATG has established a Memorandum of Agreement (MOA) with the Federal Laboratory Consortium for Technology Transfer, Midwest Region (FLC-MW) to define and translate assistive technology requirements, identify and select federal technologies for transfer, and, to develop, prototype and produce assistive technologies that are economically viable and commercially sustainable. ATG is a member of the FLC-MW Roundtable and serves as the Internet Gatekeeper for technology transfer for assistive technologies.

Past Research and Development Efforts at ATG:

Needs Assessment for Federal Technology Transfer for Individuals with Developmental Disabilities. Project Manager. State Grant Plan 95-6 Ohio Department of Mental Retardation and Developmental Disabilities, Ohio Developmental Disabilities Planning Council (ODDPC). This effort seeks to expand the technological solutions to selected problems encountered by individuals with disabilities. End user requirement assessments and technology evaluations are conducted to produce descriptions of abilities and disabilities in a classification framework that can provide appropriate requirement-technology linkages. Mechanisms of translation are applied between engineering and biobehavioral domains for the analysis of specific functional life activities and the selection of potential supporting technologies. The approach seeks to reveal how common dimensional descriptions of both human and system capabilities and limitations can facilitate purposeful technology synthesis. The approach will demonstrate how a variety of technologies and their combination can produce a general purpose and modular technology bundle that can be easily adapted to special purpose device implementations that fulfill a variety of functional activities and achieve maximum population inclusion.

Ohio Initiative in Human Systems Technology. Project Manager. State Grant Tech-96-035 Ohio Department of Development, Ohio Science and Technology Council (ODOD/OSTC). This effort developed support for a center of excellence for the advancement of the emerging industry of assistive human-systems technology and seeks to establish the State of Ohio on the leading edge of this industry. The Human Systems Technology Center would provide business access to state-of-the-art biobehavioral research and technology performed in-house or obtained through linkages with federal laboratories, universities and other institutions; provide access to education and training programs, conferences, seminars and other networking opportunities; and provide access to services that reveal the biobehavioral needs of the general population and that translate these needs into commensurate technology solutions. Activities include the identification of; the needs and market for human-systems technology; the resources for human-system technology development; mechanisms for matching needs and resources in human-systems technology, and; government, industry and academic partners.

Employee Consultant, Science Applications International Corporation (1996-2000)

Provided consulting services to the National Securities Studies and Strategies Group at SAIC, McLean, VA. Corporate support includes business development, facilitating inter-corporation strategic alliances, developing marketing strategies and supporting various marketing initiatives. Technical support is also provided to select programs. A recent program win included the Crew Centered Design Technology (CCDT) Advanced Development Project at AFRL/HE

Past Employee Consulting Efforts at SAIC:

Sensor Support to Special Operations Forces. Provided support to the Defense Advanced Research Projects Agency, Sensor Technology Office (DARPA/STO) for the identification of advanced sensor technologies to support the Special Operations Commands. As the lead for sensor technology assessment and applications support was provided to define current sensor capabilities and limitations across the full spectrum of available and in-development sensing technologies. The program goal was the identification of advanced sensing technologies that can facilitate the mission requirements of the Air Force, Army, Navy, Marine, and Joint Special Operations Forces.

NATO Special Group of Experts in Camouflage, Concealment and Deception. Provided invitational support to NATO AC/243, Special Group of Experts in Camouflage, Concealment and Deception (SGE/CCD), Working Group A: Measurements and Backgrounds, for the conduct of a three year multi-national program entitled “Background Characterization for Camouflage Pattern Development.” Program support was provided for: the development of multispectral camouflage patterns that accurately replicate background texture, the identification of US multispectral camouflage capabilities, test site selection and characterization metrics, test design and performance evaluation metrics, and test conduct to the Chairman of NATO AC/243 SGE/CCD WG-A at the US Army CECOM, Research Development & Engineering Center, Night Vision & Electronic Sensors Directorate (AMSEL-RD-NV-CD-CCD).

Survivability Integration (SURVINT) - Force Survivability and Weapons of Mass Destruction. Provided support to the Defense Special Weapons Agency (DWSA), Electronic

Systems Directorate, Survivability Assessments Division for the integration of DWSA research efforts to maximize the survivability of US forces and associated systems and infrastructure against a variety of wartime threats, to include conventional weapons, improved conventional weapons, and weapons of mass destruction. A prototype Survivability Simulation and Planning System (SSPS) was developed for the interactive analysis and planning of the employment of extant and future survivability assets to address global wartime contingencies at the unit/airbase, Joint Task Force, and Theater levels. Responsibilities included scenario definition, technology identification, selection of signature and force-on-force models, and task leadership for visual, electro-optic, laser and thermal countermeasures and modeling.

Science Applications International Corporation (1989-1996)

Corporate responsibilities included serving as an SAIC Assistant Vice President, management of the Human Systems Technology Division, and direct supervision of the Human Performance Data Management Division. Functions included Corporate, Group and Division financial and technical planning, personnel management, marketing, and Program Management for multiple technical efforts. Managed all human factors and human engineering support for the Armstrong Laboratory, Human Engineering Division, Crew Systems Integration Branch (AL/CFHI) Strategic Integration Design Evaluation Facility (SIDEF) support contract (5yr, 16M) at Wright-Patterson Air Force Base, Ohio. The Air Force Service Effort Description Area for SIDEF is Human Systems Interface: Performance Assessment and Design. The SIDEF research objective is to: a) apply multiplace/distributed human-systems design research, evaluations and assessment tools to prototype crew station designs and systems for evaluation in current (B-1, B-2) and future automated multiplace cockpits, b) assess impacts of crew aiding technologies on multiplace crew performance, workload and situational awareness, and c) conduct information requirements analysis and conceptual workstation interface designs for distributed information warfare architectures. The Multiplace and Distributed Crew Systems Technologies Program functional research and development areas include: a) Crew-Centered Aiding, Advanced Reconnaissance, Surveillance, and Target Acquisition, b) Design Assessment for Advanced Crew Systems, c) Crew Systems for Information Management and Display Technologies, d) Systems Engineering Design and Technical Analysis.

Past Research and Development Efforts at SAIC:

B-1 Sustaining Research Support Program. Human Factors lead. This Human-Systems Interface (HSI) Research Program provided the AL/CFHI Multi-Operator Design Assessment Laboratory (MODAL) and the B-1 SPO (ASC/YD) with a rapid response capability to address current and emerging issues by providing the Human Factors and Engineering expertise to address Multi-Operator Crew Aided Systems problem domains in the context of a B-1 research simulator. Human Factors research activities included: the review and analysis of multiplace/distributed human-systems design research, evaluations and assessment tools; conceptual development and prototyping of components to support crew station designs and systems for evaluation in current B-1 and future automated multiplace cockpits; development and assessment of crew aiding technologies on multiplace crew performance, workload and situational awareness; and the conduct of information requirements analyses and conceptual workstation interface designs for distributed information architectures.

B-2 Sustaining Research Support Program. Human Factors lead. This Human-Systems Interface (HSI) Research Program provided the AL/CFHI Multi-Operator Design Assessment

Laboratory (MODAL) and the B-2 SPO with a rapid response capability to address current and emerging issues by providing the capability to prototype crewstation designs and multiplace and distributed crew systems, and provided the human factors capabilities to address Multi-Operator Crew Aided Systems and Human System Interface research for multiplace cockpit control and display-related issues in the context of a B-2 research simulator and associated research tools.

Multispectral Aerosol Obscurant Effects on Synthetic Aperture Radar Target Acquisition Program. Project Manager. Provided support to the U. S. Army Edgewood Research, Development and Engineering Center, and the Naval Surface Warfare Center, Warfare Systems Department, Countermeasures Division, Research Branch to examine human target acquisition performance using Synthetic Aperture Radar (SAR) systems in an air-to-ground offensive when defensive multispectral obscurants (MSO) are deployed. A high-resolution ground mapping radar simulator and specialized image processing algorithms were used to conduct experiments to determine separable MSO attenuation and backscatter effects on man-machine system performance during SAR target acquisition and designation processes. The research addressed multiple target classes in operationally representative simple and complex background target environments. Research objectives included development of optimized image processing algorithms to maximize an operator's ability to "see-through" various obscurant countermeasures, and, development of optimized obscurant designs.

Tactical Decision Aid Human Performance Modeling and Analysis Program. Project Manager. Provided support to the Wright Laboratory, Avionics Directorate, Electro-Optics Branch (WL/AARI) and the Phillips Laboratory, Geophysics Directorate, Atmospheric Sciences Division (PL/PGA) in the development, implementation and integration of visual detection, identification and recognition ranging algorithms to enhance the various Tactical Decision Aid (TDA) models (Infrared, Direct View, Electro-Optical, Television, and Laser TDAs') predictive capabilities. The visual system algorithms were based on a space/spatial frequency pyramid representation incorporating physiologic adaptive luminance and contrast gain control mechanisms. Laboratory analysis and psychophysical experimentation supported the parameterization and subsequent integration into the Air Combat Targeting Electro-Optical Simulation Program (ACT/EOS) mission planning effort. The project provided Air Force mission planners accurate human performance predictive capabilities of target data embedded in Geographic Information Systems (GIS) and Global Positioning Systems (GPS) derived reference environments combined with satellite imagery and the simulation of how real-world weather effects various sensor imaging capabilities. The approach allowed for high value complex target classes and complex backgrounds to be incorporated into the various TDA models and the ACT/EOS with accurate predictive modeling capabilities.

Advanced Vision Concepts Program: Tristimulus Laser Protection Concept Design. Provided support to the Wright Laboratory, Materials Directorate, Laser Hardened Materials Branch (WL/MLPJ) for the design of optimized spectral transmittance profiles for aircrew tristimulus laser protective devices under the Advanced Vision Concepts Program. The design approach included considerations of threat laser systems, the spectral properties of the environment (target scene and atmospherics), human visual system processing of chromatic and luminance signals, materials science limitations (rugate technologies), airframe (cockpit lighting and canopies), and aircrew acceptance, to optimize design parameters for maximum visual performance capabilities.

Camouflage, Concealment, Deception and Obscuration (CCDO) Program. Project Manager. Providing human factors, human engineering, and research technical-analytic support to AL/CFH for concept development and both laboratory and field, test and evaluation of various CCDO techniques to support Air Base Operability and Survivability (ABOS) initiatives. Research includes the design, development, and implementation of an advanced Texture Image Processing System (TIPS) to enable the conduct of research for the development and evaluation of spatial camouflage and disruptive patterns. Multispectral texture generation algorithm concepts are being developed for the development and evaluation of site-specific urban and foliated spatial camouflage patterning.

B-2 Cursor Design and Mechanization Program. Sponsored by the B-2 Systems Program Office (SPO), this program supported human factors research in the AL/CFHI B-2 simulator for the development and optimization of display cursor design and mechanization. Responsibilities included cursor mechanization design, and experimental design and evaluation in B-2 mission relevant contexts for Synthetic Aperture Radar (SAR) updates, and using a simulation of the Global-Positioning Aided Targeting System (GATS).

Fixed Facility Camouflage, Concealment and Deception Joint Test and Evaluation (JCCD): Test Design. Project Manager for Program Test Design. Provided support to the Office of the Secretary of Defense, Under Secretary of Defense, Acquisition, (OSD USD(A)), Weapons Systems Assessment, Special Test and Evaluation Program (WSA/STEP) and the JCCD Joint Test Force for the development and conduct of the JCCD Test and Evaluation program (4yr, 32M). Developed JCCD Program Test Design (PTD) document. This defined program test objectives, methodology, procedures, scenario requirements, and all test site requirements including ground and airborne instrumentation, data reporting formats, flight operation requirements, and environmental and safety assessments. Subsequent support was provided to develop the Program Test Plan, Program Database Management and Analysis Plan, Target Characterization Requirements, and Program Human Factors Plan. Created the Human Performance Data Management Division, to support the ongoing JCCD program conduct for the quantitative evaluation of the effectiveness of CCD against all modern threat weapons systems.

Laser Guided Weapons Countermeasures Program. Sponsored by the Defense Weapons Systems Agency and the Air Force Aeronautical Systems Center (ASC/YQ), this program is developing active countermeasure (CM) systems to defeat threat laser guided weapon systems. Responsibilities included analysis, development and systems specification for laser designation detection and signal processing, CM response algorithms, CM laser transmitters, beam transport systems, end optics, damage minimization zones, and evaluation of the adaptability of the proposed CM defensive systems against future precision guided weapon threats.

Deceptive Technique Evaluation Program. Project Manager. Camouflage, Concealment and Deception (CCD) research efforts involved (a) the development and evaluation of hybrid CCD techniques (b) the development and evaluation of aircraft masking patterns (c) experimentation on the perceptual basis of the deceptive effectiveness of 2-D decoys and masking patterns (d) luminance and chrominance tonedown strategies for air base facilities (e) large scale static and dynamic visual disruption techniques, (f) fixed facility decoy and signature reduction and enhancement techniques, and (g) requirements specifications for spectral properties of false operating surfaces. Supported various CCD field evaluations including Dusty Demo, Gallant Eagle and Creek Shadow. Responsibilities included all aspects of (a) data acquisition and analysis for visual, infrared and radar treatments (b) aircrew pre-brief, de-brief and questionnaire development, and (c) radar bomb scoring data and head-up display (HUD) analysis for various fighter aircraft sensor imagery.

Ideal Masking Pattern Program. Project Manager. Under Air Force Armstrong Laboratory, Directors Funding initiative developed a biologically-based parallel image processing system to compute optimal 2-dimensional spatial camouflage and masking patterns. The resulting Advanced Texture Image Processing System (ATIPS) combines spatially global (Fourier), spatially local (physiologic) and traditional image processing technologies into a common processing architecture for the rendering of ideal camouflage/ masking designs for any arbitrary environmental scenario.

Aim Sight Phase I Development Program. Human Systems Interface (HIS) lead designing, interfacing, and demonstrating advanced man-machine interfaces (MMI) in a full mission simulation for the B1-B and advanced strategic aircraft. Developed multisensor integration concepts and crew coordination and control integration concepts for a head-steerable FLIR (forward-looking infrared) imaging system applied to a night vision airborne reconnaissance search task and weapons delivery for strategic relocatable targets. Developed a virtual environment MMI demonstration capability provided to the Visually Coupled Airborne Systems Simulator (VCASS) Super Cockpit Program.

Optical Countermeasures (OCM) Program. Project Manager. Provided technical and experimental direction in the development, analysis and evaluation of various laser countermeasures against the human visual system and sensor/weapons systems. Research was conducted to evaluate OCM effects on aircrew performance including aircraft control, visual acuity, contrast sensitivity, visual perimetry and target detection, identification, and designation. Research efforts included the development of an interactive flight simulation capability for the evaluation of laser OCM on aircrew performance within the context of mission relevant scenarios for air base attack operations. Developed first approved protocol for direct intraocular laser exposure in humans to support research efforts.

The 4th Space Warning Squadron (4 SWS), Mobile, Survivability Improvement Program. Sponsored by the Defense Weapons Systems Agency, Strategic Command and Control Division (DWSA/NASC) this program improved the survivability of the Air Force Space Command, 21st Space Wing, 4 SWS during deployed ballistic missile warning operations. The program included analysis of exploitable identifying signatures for all operational phases and deployment locations across both the strategic and tactical conflict engagement spectrum to develop a comprehensive multispectral deceptive program. Responsibilities included task leadership for signature analysis and deceptive technique development for visual, thermal, radar, electronic, acoustic, and olfactory signature reduction.

ACE and SHAPE Alternate War Headquarters Deceptive Practices Programs. Provided technical analysis and test planning support to the Defense Nuclear Agency for both the Allied Command Europe (ACE), and the Supreme Headquarters Allied Program in Europe (SHAPE) Alternate War Headquarters Deceptive Practices Programs (ACE AWHQ/DPP, and SHAPE AWHQ/DPP). Developed and provided various CCD concepts, technologies and techniques for AWHQs (both existing and interim) and supported subsequent field testing for HQ AFCENT at the NATO Camouflage of Mobile Command and Control Elements (CAMCOE Phase II and III) exercises to evaluate CCD effectiveness.

Advanced Vision Concepts Program Support. Provided support to the Wright Laboratory, Materials Directorate, Laser Hardened Materials Branch (WL/MLPJ) Advanced Vision Concepts Program for the development of aircrew laser protective visors based on selective spectral transmission, dynamic temporal response, and gradient neutral density concepts. Support included: a) detailed analysis of the laser protection concepts which included a theoretical evaluation of protection capabilities, impacts on visual performance, and design requirements for device fabrication, and, b) development of a psychophysical test plan to evaluate the impacts of the laser protection concepts on relevant measures of basic visual function, man-machine system performance, and mission effectiveness.

Project CABLE. Project Manager. In conjunction with WL/AARI, ASC/YQ, and AL/CFH established a Memorandum of Understanding with the German Military Defense, Forschungsinstitut fur Optik (FGAN-FfO), and Industrieanlagen - Betribsgesellschaft (IABG/WVT), Military Installations and Image Processing to conduct the Joint German-US Project CABLE, (Camouflage of Air Bases, example Leipheim) to implement and field test various CCD measures designed to defeat airborne infrared acquisition systems. Developed program test plan for CCD treatments, data acquisition and analysis, sensor and imagery analysis, pilot pre-brief, interview and questionnaire. Developed and implemented visual/thermal decoys and masking patterns for field-test and conducted subsequent laboratory analysis and experimentation with field imagery.

Multispectral Smoke Obscuration Modeling. Project Manager. Developed a Silicon Graphics based flight simulation capability for the Aeronautical Systems Center, Integrated Engineering/Technology Management Directorate, Crew Systems Branch (ASC/EN) to research Infrared Smoke Obscuration Requirements for the denial of air to ground target acquisition. Conducted research program using simulated LANTIRN imagery to evaluate target acquisition as a function of airborne obscurant density using an equivalent contrast reduction technique.

Additional research efforts on SIDEF with significant support roles include:

Concept I Demonstration. Human factors lead in the development and implementation of image extraction algorithms for evaluating the performance of computer vision systems for image recognition and Automatic Target Cueing (ATC) using synthetic aperture radar (SAR) imagery. In support of the Strategic Relocatable Target (SRT) Program developed a Signal Detection Theory paradigm to evaluate man-machine system performance for real-time air-to-ground SRT acquisition using the Strategic Avionics Battle-management Evaluation Research (SABER) simulator.

Advanced Target Acquisition System (ATAS) Conceptual Studies. Assisted Strategic Air Command (SAC) in establishing system performance requirements for ATAS deployment concepts and configurations, and evaluate ATAS performance with flight simulation experimentation for various SAC missions.

Radar Warning Receiver Human Factors Study. Designed and conducted research to evaluate human performance, situation awareness and workload for an integrated vs. stand-alone radar warning receiver in the B1-B defense management system configuration.

Strategic Mission Analysis. Developed a B-1 relocatable target mission, conceptual control and display concepts, and supported simulation studies to evaluate man-system performance.

Automatic Map Cueing Evaluation. Conducted B1-B OSO task analysis, mission decomposition and development, and conduct experiments to evaluate new Automatic Map Cueing system.

Phase II Color Research. Designed and tested man-machine interface (MMI) concepts and advanced defensive display color formats for the B1-B Defensive System Officer's displays.

Additional research has included support to the Aeronautical Systems Center (ASC/XR) Specialized Short Term Development Planning Support contract. Support was provided to the Human Systems Division (HSC/XR):

a) In visual requirements analysis and future technology assessment for the ***Tactical Night Vision Program***, and the ***Night Vision Goggles Requirements Analysis and Technology Assessment Program***. Contributions included requirements analysis, technology assessment, mission analysis and trade studies for future night vision goggle and integrated helmet mounted display/sight systems for night low level visual navigation, targeting and weapon delivery.

b) In visual requirements analysis for the ***Close Air Support/Battlefield Air Interdiction and Reconnaissance Night Attack Sensor System Program***. Contributions included determining Tactical Air Command vision requirements for fixed and head-steered navigation, targeting and information (NTI) systems (both HMD and NVG targeting) to support Army operations with 24-hour CAS, BAI, and RECCE missions for the F-16.

Past efforts also included a compartmentalized program for the design, research and development for advanced sensor and display technology applications combining sensor fusion, real-time physiologic image processing, and multispectral hybrid display applications.

Systems Research Laboratories (1985-1989)

Concurrent program manager for the Optical Countermeasures (OCM) and the Camouflage, Concealment and Deception (CCD) programs at the Armstrong Aerospace Medical Research Laboratory (AAMRL) under the Human Engineering Support contract. While managing these two programs grew the full-time technical support staff from one to seven individuals. Management responsibilities included budget control, proposal development and directing a team of human factors and engineering personnel. Research responsibilities included problem definition, preparation and review of experimental protocols, conducting experiments, resource control and allocation, and documentation of results.

OCM research assessed visual performance for various aircraft and weapons systems to develop effective deployment and defense strategies for various optical countermeasure techniques. Direct interocular exposure to various threat lasers predominated the research programs. These included: dynamic target acquisition and visual tracking performance, measures of transient visual field losses, the effects of windscreens and personnel protective visors, spectral analysis of various optical media, quantification of beam profiles and scatter effects, and measures of spatial contrast sensitivity in the presence of structured exposures as a function of wavelength, target contrast, and adaptation level. Developed a review concerning metrics of eye safety with respect the thermal, photoacoustic, and photochemical hazards involved in laser exposure.

CCD research involved the development and evaluation of camouflage, concealment and deception related practices. This included active and passive aircraft visual signature reduction, air base luminance and chrominance tonedown strategies, the use of 2-D silhouette decoys, and deceptive 2-D masking and shape disruptive patterning analysis. Research efforts also included developing a physiologically based vision model to predict detection thresholds of arbitrary space-time separable stimuli using a 4-D foveated space/spatial-frequency Gabor pyramid representation. Developed a new methodology for the derivation of optimal masking patterns and camouflage design based on psychophysical theories of visual system processing of pattern information.

University of Alabama at Birmingham Medical School (1984-1985)

Visual Neurophysiologist, Vision Science Research Center. Conducted detailed measures of spatial modulation transfer functions of physiologically identified neurons in the lateral geniculate nucleus (LGN) of Galago crassicaudatus, a prosimian primate. Difference-of-Gaussians modeling of center-surround organization for single-cell spatial contrast sensitivity functions was used to test current models of spatial receptive-field organization and to derive parameters specifying receptive-field spatial and sensitivity attributes for analysis. The results demonstrated fundamental differences in the spatial organization of the W, X, and Y LGN cell classes which mediate the relay of visual information to primary visual cortex. A comparison with other visual processing and physiologic response characteristics provided a better understanding of spatial processing in the primary visual pathway.

EDUCATIONAL EXPERIENCE

National Eye Institute Postdoctoral Fellow (1982-1984)

University of Alabama Medical School at Birmingham, Vision Science Research Center. Developed technologies and instrumentation necessary to conduct intracellular recording with horseradish peroxidase (HRP) staining techniques. Developed and implemented procedures for manufacturing and beveling glass capillary micropipettes, extracellular and intracellular recording techniques and instrumentation, physiological classification of neuronal response properties, iontophoresis of HRP, histological processing and histochemical staining of brain tissue, and morphological reconstruction of neurons. These inclusive techniques allowed the recovery of the complete detailed morphology of individual neurons in the Superior Colliculus of the tree shrew after physiological classification in the temporal and spatial domains using computer driven stimuli. These structure-function studies allowed a direct comparison between the information processing capacities of individual neurons and their specific morphological structure. Analysis examined relationships between physiologic response properties, cellular morphology, and connectivity.

Postdoctoral Research Associate, Visual Neurophysiology (1981-1982)

University of Alabama Medical School at Birmingham, Department of Physiological Optics. In a collaborative effort with Vanderbilt University Departments of Cell Biology and Psychology examined the receptive-field organization of relay cells in the lateral geniculate nucleus (LGN) of both normal and monocularly deprived Galago, a prosimian primate.

The studies in normal Galago demonstrated that W, X, and Y relay cells are segregated by LGN laminae in accordance with cell size distributions. Additionally, cells histologically localized to the interlaminar zones (ILZs) of the LGN exhibit W-cell response properties; a new finding consistent with the similar morphology and anatomical connections that ILZs share with W-cell LGN laminae across mammalian species. This significant discovery strongly supports the conclusions that: a) both the ILZs and koniocellular layers in the Galago LGN convey W-like visual information from retina to cortex, and, b) in higher primates the W-cell pathway is preserved in the LGN intercalated layers, and that the full compliment of W, X, and Y pathways participate in the encoding and transmission of visual information from retina to cortex.

Provided the first report of the effects of monocular deprivation on the physiological response properties of relay cells in the LGN of a primate. Comparison of physiologically identified relay cells histologically localized to deprived vs. non-deprived LGN laminae revealed no alteration in the distribution of functional properties of any cell class despite a reduction in cell size of the deprived LGN laminae. This result disallowed previous models of deprivation induced amblyopia based on a direct competition between X and Y retinal afferents for post-synaptic targets within the main layers of the LGN. Proposed a new model of developmental amblyopia in primates that resulted from cortical changes due to reduced input from the deprived LGN laminae rather than to a selective loss of input from a particular functional cell class.

Graduate Research Fellow, Biopsychology Program (1978-1980)

Syracuse University, Department of Psychology. Doctoral Thesis: "Psychophysical Determinants of Temporal Processing in the Human Fovea." Measured foveal temporal processing characteristics using a combination of the Two-Pulse paradigm and Stiles' two color increment threshold technique. The results demonstrated that, in the temporal domain, the fovea behaves as a low-pass filter at absolute threshold independent of stimulus size. In the light adapted state, low-pass filter characteristics are observed provided stimulus size is within the limits of intensity-area reciprocity. Beyond these limits, foveal filter characteristics are band-pass and exhibit a progressively increasing low frequency attenuation (greater inhibitory effects) either as a function of increasing stimulus size or background luminance. Additionally, the results demonstrated the necessity for temporal processing models to accurately account for temporal probability summation effects.

Graduate Research Fellow, Physiological Psychology Program (1977-1978)

Syracuse University, Department of Psychology, Visual Psychophysics Laboratory. Investigated monoptic and dichoptic contributions to temporal brightness enhancement, demonstrating that the Broca-Sulzer effect originates before the combination of the individual monocular pathways at the cortical level. Also, isolated and characterized the contributions of sustained and transient mechanisms to brightness enhancement effects utilizing a unique spatio-temporal stimulus paradigm to produce and control selective transient adaptation.

Characterized brightness and darkness sensations in the human fovea using multidimensional and suprathreshold scaling techniques. Discovered and characterized asymmetries between brightness and darkness percepts in terms of sensation magnitude, flash durations producing maximal sensation, and in the minimal luminance changes necessary for brightness and darkness enhancement effects to be produced. Demonstrated that brightness and darkness sensations are generated by separate neuronal systems.

Graduate Research Associate (1976-1977)

Syracuse University, School of Engineering, Institute for Sensory Research, and Department of Psychology, Visual Psychophysics Laboratory. Investigated contextual determinants of perceived length illusions using absolute magnitude estimation. Demonstrated that when all visual cues to context are eliminated, including contextual reference cues based on the limits of the visual field, the Horizontal-Vertical Illusion does not exist. Additionally, investigated methodological determinants of the Law of Size Constancy by scaling perceived line length as a function of viewing distance. Perceived length obeys the Law of Size Constancy when viewing distance is varied within sessions, whereas, across sessions perceived length increases as an inverse function of viewing distance.

Undergraduate Research Assistant (1974-1976)

Syracuse University, Department of Psychology. Supported National Eye Institute grant research "Mechanisms of Visual Sensitivity". Investigated spatial dependence of rod-cone interactions measured on scotopically equated adapting fields using the Crawford early light and dark adaptation paradigm. Temporal profiles of size dependent rod-cone interactions during transient light adaptation were characterized.

REPRESENTATIVE PUBLICATIONS, PRESENTATIONS, AND REPORTS

1) Irvin, G.E. *Laser Hardening Night Vision Goggles: An Interim Solution to Fixed and Agile Laser Threats Using a Complimentary Comb Fixed Filter Approach* AFRL/RXPJ Night Agile Laser Eye Protection Advanced Technology Demonstration, NALEP, ATD, 79 pp., June 2010.

2) Irvin, G.E. *Display Compatibility Modeling for Laser Eye Protection.* Directed Energy Systems Symposium, Directed Energy Effects Mitigation Tactical Session, United States Navy, Naval Postgraduate School, Monterey, CA, April, 2010.

3) Irvin, G.E. *Advanced Optical Coatings Monolithic Demonstration: Program Review and Laboratory Demonstration Update,* Air Force Research Laboratory, Materials and Manufacturing Directorate, and, F-35 Joint Strike Fighter Systems Program Office, ASC 604th Aeronautical Systems Squadron, 312/326 Aeronautical Systems Wing, Dayton, OH, February 2010.

4) Irvin, G.E. *Design and Manufacturing Exercise for an All-Dye Out-of-Band (OOB) Laser Eye Protection (LEP) Visor),* Air Force Research Laboratory, Materials and Manufacturing Directorate, Technical Report, Secret 17 pp, January, 2010.

5) Irvin, G.E. *Advanced Optical Coatings Hybrid Visor and Monolithic Spectacle Laser Eye Protection Manufacturing Demonstration, (AOC Mono Demo),* Air Force Research Laboratory, Materials and Manufacturing Directorate, Technical Report, Secret 42 pp, January, 2010.

6) Irvin, G.E. and Cahill, P.A. *Predicted Performance for Structural Variations of the TBAF-1 Dye: Selection Process for Candidate Synthesis Options,* Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, January 2010.

7) Irvin, G.E. *Advanced Optical Coatings Monolithic Demonstration: System 10 Baseline and Enhanced Prototype Manufacturing Results,* Air Force Research Laboratory, Materials and Manufacturing Directorate, and, F-35 Joint Strike Fighter Systems Program Office, ASC 604th Aeronautical Systems Squadron, 312/326 Aeronautical Systems Wing, Dayton, OH, December 2009.

8) Irvin, G.E. *All-Dye Daytime Army LEP Spectacle Design and Manufacturing Demonstration,* Technical Report, Visor Technology Demonstration, Hardened Materials Research and Survivability Studies (HMRSS), Secret 18 pp, November, 2009.

9) Irvin, G.E. *Army LEP Design Initiative: Performance Goals and Initial Designs,* Army LEP Spectacle Demonstration Review, Visor Technology Demonstration, Hardened Materials Research and Survivability Studies (HMRSS), November, 2009.

10) Irvin, G.E. *3CCD Program: Laser Hardening of Prism-Based Visible 3 CCD Sensors,* Final Report, Advanced Hardening Technologies, Studies on Materials and Processes for Personnel Protection, Secret 23 pp, October, 2009.

11) Irvin, G.E. *JSF Visor Design Initiative, F-35 Joint Strike Fighter All-Dye Laser Protection Visor Design Initiative*, Final Report, Advanced Hardening Technologies, Studies on Materials and Processes for Personnel Protection, Secret 35 pp, October, 2009.

12) Irvin, G.E. *JHMCS (Joint Helmet Mounted Cueing System) Design Initiative, Visor and Hybrid Spectacle-Visor Laser Eye Protection Systems for JHMCS,* Final Report, Advanced Hardening Technologies, Studies on Materials and Processes for Personnel Protection, October, 2009.

13) Irvin, G.E. *Interim Agile Laser Hardening for Night Vision Goggles Research, Agile Night Vision Goggle Laser Hardening: A Visual Information Approach using Complimentary Comb Filters,* Final Report, Advanced Hardening Technologies, Studies on Materials and Processes for Personnel Protection, October, 2009.

14) Irvin, G.E. *Complimentary Comb Filters for Night Vision Goggle Laser Hardening*, Final Report, Advanced Hardening Technologies, Studies on Materials and Processes for Personnel Protection, Secret 35 pp, October, 2009.

15) Irvin, G.E. *Night Agile Laser Eye Protection (NALEP) Program: Field Test Evaluation of Night Vision Goggle (NVG) Laser Hardening Technologies*, Final Report, Advanced Hardening Technologies, Studies on Materials and Processes for Personnel Protection, Secret 60 pp, October, 2009.

16) Irvin, G.E. *Advanced Optical Coatings Monolithic Demonstration, Monolithic Spectacle Laser Eye Protection and Hybrid Spectacle-Visor Systems for the F-35 Joint Strike Fighter,* Final Report, Advanced Hardening Technologies, Studies on Materials and Processes for Personnel Protection, Secret 35 pp, October, 2009.

17) Irvin, G.E. *Hybrid Spectacle-Visor Design Initiative, Hybrid Spectacle-Visor Design Concepts for Helmet Mounted Display Systems, ALEP Block 2 Fighter Systems, and General Nighttime Applications*, Final Report, Advanced Hardening Technologies, Studies on Materials and Processes for Personnel Protection, Secret 31 pp, October, 2009.

18) Irvin, G.E. *Advanced Optical Concepts for Joint Strike Fighter Laser Eye Protection Critical Design Review-II: Design Trade Principals; Final Design and Modeled Perfromance,* F-35 Joint Strike Fighter Systems Program Office, ASC 604th Aeronautical Systems Squadron, 312/326 Aeronautical Systems Wing, Dayton, OH, June 2009.

19) Irvin, G.E. & Hall, R.L. *Advanced Optical Concepts for Joint Strike Fighter Laser Eye Protection Critical Design Review-II: Monolithic LEP CDR-I Design,* F-35 Joint Strike Fighter

Systems Program Office, ASC 604^{th} Aeronautical Systems Squadron, 312/326 Aeronautical Systems Wing, Dayton, OH, June 2009.

20) Irvin, G.E. *ALEP Block 2 SDD Developmental Test and Evaluation Field Testing Results for Day, Night and JHMCS*, ALEP Block 2 Systems Verification Review (SVR) and Production Readiness Review (PRR). Teledyne Scientific and Imaging, Camarillo, CA, June, 2009.

21) Irvin, G.E. *ALEP Block 2 SDD Aircraft Integration and Interface Control Working Groups, Visual and Physical Compatibility Field Testing Results for Day, Night and JHMCS*, ALEP Block 2 Systems Verification Review (SVR) and Production Readiness Review (PRR). Teledyne Scientific and Imaging, Camarillo, CA, June, 2009.

22) Maxwell, K.J., Irvin, G.E. *Laser Hardening Requirements for the HNVG Program.* Hardened Night Vision Goggle (HNVG) Critical Design Review (CDR), ITT Night Vision, Roanoke, VA, June 2009.

23) Irvin. G.E. *Human Visual Mechanisms and Photopic Luminous Transmission: Considerations for the Joint Strike Fighter*. Invited Briefing to Joint Strike Fighter Program Office, Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, May 2009.

24) Irvin. G.E. *Aircrew Flight Equipment and Visual Compatibility Field Testing, ALEP Block 2 SDD Laser Eye Protection, Night and JHMCS Variants*. Nellis Air Force Base, 53rd Test and Evaluation Group, 422nd Test and Evaluation Squadron, Las Vegas, NV, April 2009.

25) Irvin. G.E. *Joint Helmet Mounted Cueing System (JHMCS) All-Dye Design Initiative for Visor and Integrated Spectacle-Visor Laser Eye Protection Solutions*. Technical Report, 29pp, Secret, Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, April 2009.

26) Irvin. G.E. *Advanced Optical Coatings Monolithic Laser Eye Protection Designs: Visor and Hybrid Spectacle/Visor Designs and Performance Characterization*, AFRL/RXPJ Advanced Optical Coatings Critical Design Review, Dayton, OH, April 2009.

27) Irvin. G.E. *Life Support Equipment and Visual Compatibility Field Testing, ALEP Block 2 SDD Laser Eye Protection, Night Variant*, Hurlburt Field, 1st Special Operations Group, 8th, 15th and 16th Special Operations Squadrons, Mary Esther, FL, March 2009

28) Irvin, G.E. *Night Agile Laser Eye Protection (NALEP) Field Evaluations: NALEP Overview for Lasers on the Modern Battlefield.* NALEP Program, Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, February 2009.

29) Irvin. G.E. *ALEP Block 2 Aircraft Interface Working Group Meeting*, Aircrew Laser Eye Protection, ALEP Block 2, Nellis Air Force Base, December 2008.

30) Irvin. G.E. *Pre-DT&E Prototype Testing of AB2 Night Designs: Field Evaluations*, Aircrew Laser Eye Protection, ALEP Block 2 Night Critical Design Review Meeting. Teledyne Scientific and Imaging, Camarillo, CA, December, 2008

31) Irvin. G.E. *Monolithic LEP - Modified $\lambda 2$ Designs*, AFRL/RXPJ Advanced Optical Coatings Coordination Meeting, Dayton, OH, October 2008

32) Irvin. G.E. *F-22A Raptor Visual Compatibility Field Testing, ALEP Block 2 SDD Laser Eye Protection,* Langley AFB, 94th Fighter Squadron, 1st Operations Group, 1st Fighter Wing, Hampton, VA. Final Report, October 2008.

33) Irvin. G.E. *Laser Protective Visors for Joint Helmet Mounted Cueing System, JHMCS,* AFRL/RXPJ Laser Hardened Materials Program Review, Las Vegas, Nellis AFB, 16-18 September 2008

34) Irvin, G.E. *Integrated Test Team Results for the Nellis AFB Visual Compatibility Field Evaluation*, Aircrew Laser Eye Protection, ALEP Block 2 Integrated Test Team (ITT) Meeting. Teledyne Scientific and Imaging, Camarillo, CA, August, 2008

35) Irvin, G.E. *ALEP Block 2 Integrated Logistics Support*, Aircrew Laser Eye Protection, ALEP Block 2 Aircraft Integration Working Group (AIWG) Meeting. Teledyne Scientific and Imaging, Camarillo, CA, August, 2008

36) Irvin, G.E. *ALEP Block 2 Safety*, Aircrew Laser Eye Protection, ALEP Block 2 Aircraft Integration Working Group (AIWG) Meeting. Teledyne Scientific and Imaging, Camarillo, CA, August, 2008

37) Irvin, G.E. *Pre-Developmental Test &Evaluation (Pre DT&E) ALEP Prototype Testing Field Evaluations for Physical and Visual Compatibility*, Aircrew Laser Eye Protection, ALEP Block 2 Critical Design Review Meeting. Teledyne Scientific and Imaging, Camarillo, CA, August, 2008

38) Irvin, G.E. & Hall, R.L. *Monolithic Laser Eye Protection, Preliminary Design Review*, Advanced Optical Coatings Program, Air Force Research Laboratory, Materials and Manufacturing Directorate, at General Dynamics Information Technology, Dayton, OH, July 2008.

39) Irvin, G.E. *Laser Eye Protection Metameric Visor Designs to Support ALEP Block 2 Hybrid Visor-Spectacle LEP*, Advanced Hardening Technologies Program, Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, July 2008.

40) Irvin, G.E. *Life Support Equipment and Visual Compatibility Field Testing, ALEP Block 2 SDD Laser Eye Protection*, Nellis Air Force Base, 53rd Test and Evaluation Group, 422nd Test and Evaluation Squadron. Final Report, 34 pp, June 2008.

41) Irvin, G.E. *ALEP Block 2 Pre-Developmental Test and Evaluation Update: A Summary of Field Test Evaluations*. Aircrew Laser Eye Protection, ALEP Block 2 Integrated Test Team Meeting. Teledyne Scientific and Imaging, Camarillo, CA, June, 2008.

42) Irvin, G.E. *E94 Visual Compatibility Metrics*. Aircrew Laser Eye Protection, ALEP Block 2 Technical Interchange Meeting. Teledyne Scientific and Imaging, Camarillo, CA, June, 2008.

43) Irvin, G.E. *Laser Eye Protection Joint Helmet Mounted Cueing System Critical Design Review: JHMCS All-Dye Designs for Visors and Spectacle-Visor Hybrids.* JHMCS LEP CDR for Air Force Research Laboratory, Materials and Manufacturing Directorate, at General Dynamics Information Technology, Dayton, OH, March 2008.

44) Irvin, G.E. *Visor Laser Eye Protection Design Initiative for Integrated Spectacle-Visor Laser Eye Protection Solutions.* Final Report, Secret, 30pp, Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, February 2008.

45) Irvin, G.E. *Life Support Equipment and Visual Compatibility Field Testing: ALEP Block 2 SDD Laser Eye Protection*, Maryland Air National Guard, 175th Wing, 135th Airlift Squadron, Final Report, 23pp, December 2007.

46) Irvin, G.E. *Life Support Equipment Field Testing: ALEP Block 2 Laser Eye Protection, New Orleans Air National Guard*, Final Report, 11pp, November 2007.

47) Irvin, G.E. *Life Support Equipment and Visual Compatibility Field Testing: ALEP Block 2 SDD Laser Eye Protection*, *Tucson Air National Guard and Davis-Monthan AFB,* Final Report, 22pp, October 2007.

48) Irvin, G.E. *Joint Strike Fighter Laser Eye Protection Designs.* JSF Laser Eye Protection Technical Interchange Meeting (TIM), Rockwell Collins Display Systems, San Jose, CA, August 2007.

49) Irvin, G.E. *Visor Laser Eye Protection Design Initiative for Integrated Spectacle-Visor LEP Solutions.* Hybrid LEP Interim Review, U.S. Air Force HQ 77th Aeronautical Systems Group (AESG/TAAM), San Antonio, TX, July 2007

50) Irvin, G.E. *Joint Strike Fighter (JSF) Laser Eye Protection System Development Program: Initial Design Feasibility Study*. Final Report, Joint Strike Fighter (JSF) Laser Eye Protection (LEP) System Development Program, 16pp, June 2007.

51) Irvin, G.E. *JCAS Trade Study Methodology*. JCAS CDR: JHMCS (Joint Helmet Mounted Cueing System) Compatible Aircrew Laser Eye Protection (ALEP) Critical Design Review. Teledyne Scientific and Imaging, Camarillo, CA, June, 2007.

52) Irvin, G.E. *Solar Exposure Effects Analysis*. JCAS CDR: JHMCS (Joint Helmet Mounted Cueing System) Compatible Aircrew Laser Eye Protection (ALEP) Critical Design Review. Teledyne Scientific and Imaging, Camarillo, CA, June, 2007.

53) Irvin, G.E. and Rea, E.J. *Jamming Analysis and 3 Color Separation. Spectral Separation: 3CCD Spectral Band Optimization for Laser Hardening Performance*. Tri-Service CCD Hardening Program Review, Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, 4-6 June 2007.

54) Irvin, G.E. *Trade Study Methodology for Preliminary Designs*. ALEP Block 2 Program Preliminary Design Review. Teledyne Scientific and Imaging, Camarillo, CA, May, 2007.

55) Irvin, G.E. *JCAS Prototype Spectacles: Analysis and Characterization*. JCAS TIM: JHMCS (Joint Helmet Mounted Cueing System) Compatible Aircrew Laser Eye Protection (ALEP) Technical Interchange Meeting. Teledyne Scientific and Imaging, Camarillo, CA, May, 2007.

56) Irvin, G.E. *ALEP Block 2 Interface Control Working Group (AIWG) and Aircraft Integration Working Group (ICWG) Meeting #3*. ALEP Block 2 Program Preliminary Design Review. Teledyne Scientific and Imaging, Camarillo, CA, May, 2007.

57) Irvin, G.E. *Joint Strike Fighter Laser Eye Portection Visor Preliminary Design Review*. Advanced Hardening Technologies, Studies on Materials and Processes for Personnel Protection,

Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, March 2007.

58) Irvin, G.E. *Aircraft Integration Working Group (AIWG) Coordination Meeting; Charter and Membership Responsibilities*. ALEP Block 2 Program Technical Interchange Meeting. Teledyne Scientific and Imaging, Camarillo, CA, February, 2007.

59) Irvin, G.E. *Interface Control Working Group (ICWG) Coordination Meeting; Charter and Membership Responsibilities*. ALEP Block 2 Program Technical Interchange Meeting. Teledyne Scientific and Imaging, Camarillo, CA, February, 2007.

60) Irvin, G.E. *Interim Agile Laser Hardening for Night Vision Goggles.* Technical Report, Secret, 71pp, Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, January 2007.

61) Irvin, G.E. & Rea, E.J. *Optec 3CCD Prism Characterization and Defining Ideal BRG Primaries for Sensor Hardening.* 3CCD Coordination Meeting, Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, December, 2006.

62) Irvin, G.E. *In-Cockpit Spectral Characterization of the FA-22 Raptor at Langley Air Force Base*. ALEP Block 2 Interim Baseline Review for U.S. Air Force HQ 77th Aeronautical Systems Group (AESG/TAAM), Teledyne Imaging Sensors, Camarillo, CA, October, 2006.

63) Irvin, G.E. *Laser Eye Protection Design Constraints*. ALEP Block 2 System Requirements Review for U.S. Air Force 311th Human Systems Wing, HSG/APAM, Rockwell Science Center, Camarillo, CA, August, 2006.

64) Irvin, G.E. *ALEP Block 2 Aircraft Interface Working Group Charter*. ALEP Block 2 System Requirements Review for U.S. Air Force HQ 77th Aeronautical Systems Group (AESG/TAAM), Rockwell Science Center, Camarillo, CA, August, 2006.

65) Irvin, G.E. *Laser Eye Protection in Support of the Department of Homeland Security*. Invited presentation at the USAF Laser Hardened Materials Program Review (LHMPR), National Institute of Science and Technology (NIST), Boulder, CO, July, 2006.

66) Irvin, G.E. *Advances in Night Vision Goggle Complimentary Comb Filters*. Invited presentation at the USAF Laser Hardened Materials Program Review (LHMPR), National Institute of Science and Technology (NIST), Boulder, CO, July, 2006.

67) Irvin, G.E. *Assessment of Joint Strike Fighter Display Compatibility with Laser Eye Protection Spectacles*, Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, May, 2006.

68) Hall, R. & Irvin, G.E. *Rapid Response Designs: Optical / Physical Performance.* Joint Helmet Mounted Cueing System (JHMCS) Compatible Aircrew Laser Eye Protection (ALEP) System (JCAS), Rapid Response Variant and Preliminary Design Review (PDRR) for U.S. Air Force 311th Human Systems Wing, HSG/APAM, Rockwell Science Center, Camarillo, CA, April, 2006.

69) Irvin, G.E. & Lukins, R. *Plan for Aircraft and Life Support Compatibility Documentation.* Joint Helmet Mounted Cueing System (JHMCS) Compatible Aircrew Laser Eye Protection (ALEP) System (JCAS), Rapid Response Variant and Preliminary Design Review (PDRR) for

U.S. Air Force 311th Human Systems Wing, HSG/APAM, Rockwell Science Center, Camarillo, CA, April, 2006.

70) Irvin, G.E. *JCAS Phase 2 Optical Designs.* Joint Helmet Mounted Cueing System (JHMCS) Compatible Aircrew Laser Eye Protection (ALEP) System (JCAS), Rapid Response Variant and Preliminary Design Review (PDRR) for U.S. Air Force 311th Human Systems Wing, HSG/APAM, Rockwell Science Center, Camarillo, CA, April, 2006.

71) Irvin, G.E. *Joint Strike Fighter Coordination Meeting: Design Tool Demonstrations, the Integrated Spectral Transmission Optimization Research Model, ISTORM,* Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, March, 2006.

72) Irvin, G.E. *Joint Strike Fighter Coordination Meeting: Visual Requirements for JSF Laser Eye Protection,* Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, March, 2006.

73) Irvin, G.E. *FA-18 and JHMCS Field Spectral Measurements*. Joint Helmet Mounted Cueing System (JHMCS) Compatible Aircrew Laser Eye Protection (ALEP) System, JCAS, Technical Interchange Meeting (TIM). Air Force Material Command, Headquarters, Human Systems Group, HQ HSG/YA, Brooks City Base, San Antonio, TX, March 2006.

74) Irvin, G.E. *JCAS LEP Optical Designs and Visual Compatibility Performance for Spectacle and Hybrid Spectacle/Visor Configurations*. Joint Helmet Mounted Cueing System (JHMCS) Compatible Aircrew Laser Eye Protection (ALEP) System, JCAS, Technical Interchange Meeting (TIM). Air Force Material Command, Headquarters, Human Systems Group, HQ HSG/YA, Brooks City Base, San Antonio, TX, March 2006.

75) Irvin, G.E. *Flight Engagement Modeling: Analysis of Eye Accessibility and Vulnerability to Laser Threat Systems for Various Spectacle Configurations*. Joint Helmet Mounted Cueing System (JHMCS) Compatible Aircrew Laser Eye Protection (ALEP) System, JCAS, Technical Interchange Meeting (TIM). Air Force Material Command, Headquarters, Human Systems Group, HQ HSG/YA, Brooks City Base, San Antonio, TX, March 2006.

76) Irvin, G.E. *JCAS Optical Design Constraints.* Joint Helmet Mounted Cueing System (JHMCS) Compatible Aircrew Laser Eye Protection (ALEP) System, JCAS, System Requirements Review (SRR) for U.S. Air Force 311th Human Systems Wing, HSG/APAM, Rockwell Science Center, Camarillo, CA, December, 2005.

77) Irvin, G.E. *Advances in LEP Technology: Impact of Absorptive Dye Syntheses Efforts,* AFRL Science Advisory Board 2005, Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, November, 2005.

78) Irvin, G.E. *Laser Eye Protection Design Methodologies for Determining Dye Components,* Joint Helmet Mounted Cueing System (JHMCS) Compatible Aircrew Laser Eye Protection (ALEP) System, JCAS, Kick-off Meeting for U.S. Air Force 311th Human Systems Wing, HSG/APAM, Rockwell Science Center, Camarillo, CA, October, 2005.

79) Irvin, G.E. *Interim Agile Laser Protection for Night Vision Goggles: Out-of-Band and Complimentary Comb Design Review: Analysis of RSC Designs*. Hardened Night Vision Goggle (HNVG) Interim Design Review, Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, September, 2005.

80) Irvin, G.E. *Interim Agile Laser Protection for Night Vision Goggles: Out-of-Band and Complimentary Comb Design Review: Analysis of Initial Designs*. Hardened Night Vision Goggle (HNVG) Coordination Meeting, Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, September, 2005.

81) Edmonds, B.P., Maxwell, K.J. and Irvin, G.E. *Laser Eye Protection Capability Review and Recommendations to Eye Protection Task Force*. Report to Air Force Research Laboratory, Materials & Manufacturing Directorate, Hardened Materials Branch, AFRL/MLPJ, September 2005 (Secret).

82) Irvin, G.E. *An Assessment of the Impact on Visual Compatibility for Providing Laser Eye Protection in the Red Laser Pointer Region*. Report to Air Force Research Laboratory, Materials & Manufacturing Directorate, Hardened Materials Branch, AFRL/MLPJ for U.S. Air Force 311th Human Systems Wing, HSG/APAM, July 2005.

83) Irvin, G.E. *Interim Agile Laser Protection for Night Vision Goggles: Out-of-Band and Complimentary Comb Filter Requirements and Design Concept Review*. Sonoma Photonics Coordination Meeting, Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, May, 2005.

84) Irvin, G.E. and Rea, E.J. *Spectral Characterization of Vehicles to Support Visual Compatibility Assessments and Laser Hardening Requirements*. Report to Department of Homeland Security and U.S. Secret Service, April, 2005.

85) Irvin, G.E. *Visual Requirements for the F-35 Joint Strike Fighter In-Cockpit Visual Compatibility.* Joint Strike Fighter Coordination Meeting, Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, March, 2005.

86) Irvin, G.E. *ISTORM: Integrated Spectral Transmission Optimization Research Model, Capabilities Overview.* Joint Strike Fighter Coordination Meeting, Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, March, 2005

87) Irvin, G.E. *Dual-frequency Cholesteric Filtering Effects on NVG Target/Background Contrast and Visual Detection Range performance for 2-Bin and 3-Bin Filter Configurations*. Invited presentation, AFRL/MLPJ & ITT Night Vision Hardened Night Vision Goggle (HNVG) Program Review, Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, March, 2005.

88) Irvin, G.E. *NVG OOB and CComb Filter Review, Out-of-Band and Complimentary Comb Filters for NVG Hardening*. Invited presentation, AFRL/MLPJ & Rockwell Scientific Company Advanced Optical Coatings, Night Vision Goggle and Laser Eye Protection Review, Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, March, 2005.

89) Irvin, G.E *Visor Designs, Characterization and Analysis for the Joint Strike Fighter Helmet Mounted Display System (JSF NMD)*. Final Report, Kaiser Electronics, Rockwell Collins, San Jose, CA, February, 2005.

90) Irvin, G.E. *Dual-frequency Cholesteric Filtering Impact on NVG system performance for 2-Bin and 3-Bin Filter Configurations*. Final Report. ITT Night Vision Hardened Night Vision Goggle (HNVG) Program, Roanoke, VA, November, 2004.

91) Irvin, G.E. *Fixed and Agile Filter Design Applications to Support Laser Hardening Materials and System Development Final Report.* Materials and Manufacturing Directorate, Air

Force Research Laboratory, Air Force Material Command, Wright Patterson Air Force Base, OH, December, 2004.

92) Irvin, G.E., Gaska, J.P. Hardened Night Vision Goggle Modeling. *AFRL/MLPJ Software Modeling Summit*. Dayton, OH, 15 December, 2004.

93) Irvin, G.E. *NVG Complimentary Comb Filter Review: Requirements, Designs, Prototypes, Performance and Field Testing.* Invited presentation at the AFRL HNVG CComb Program Review, Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, July, 2004.

94) Irvin, G.E., Gaska, J.P. *Hardened Night Vision Goggle (HNVG) Program: NVG Modeling for Dual-Frequency Cholesteric Liquid Crystals (DF-ChLCs).* Invited presentation, AFRL HNVG Program Review, Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, July, 2004.

95) Irvin, G.E. *Hardened Night Vision Goggle (HNVG) Program Review: NVG Modeling Status, Visual Performance and Cholesteric Filters.* Invited presentation at the AFRL HNVG Program Review, Rockwell Scientific Company, Thousand Oaks, CA, June 2004.

96) Irvin, G.E. *Fixed and Agile Filter Design Applications to Support Laser Hardening Materials and Systems Development.* LHMAS Delivery Order 18 Program Review, Mobium Enterprises, Inc., Dayton, OH, June, 2004.

97) Irvin, G.E. *Tristimulus Design Evolution using Green-1*. Invited presentation at the USAF Technical Coordination Meeting with 311th HSW/ YACLM Human Systems SPO, Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, April, 2004

98) Irvin, G.E. *Hardened Night Vision Goggle (HNVG) Modeling.* Invited presentation at the USAF AFRL HNVG Kickoff Meeting, ITT Night Vision Laboratories, Roanoke, VA, April 2004.

99) Irvin, G.E. *Hardened Night Vision Goggle (HNVG) Program Review, NVG Modeling Status: Visual Performance and Cholesteric Filters*. Invited presentation at the USAF AFRL HNVG Program Review, Rockwell Scientific Company, Thousand Oaks, CA, June 2004.

100) Irvin, G.E. *Hardened Night Vision Goggle (HNVG) Program: Out-of-Band, Out-of-Band Plus and Complimentary Comb Filter Designs and Prototypes.* Invited presentation, AFRL HNVG Program Meeting, Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, July, 2004.

101) Irvin, G.E. *Flight Engagement Accessibility Modeling: Hardened NVG Design Considerations*. Invited presentation at the USAF Quarterly NALEP Tri-Directorate Technical Coordination Meeting, Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, December 2003

102) Irvin, G.E. *Night Vision Goggle Fixed Filter Designs and Design Philosophy*. Invited presentation at the USAF Quarterly NALEP Tri-Directorate Technical Coordination Meeting, Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, December 2003

103) Irvin, G.E. *Spectral Embedding Methodologies Applied to Agile Laser Hardening: Implications for Eye and Sensor Hardening*. Invited presentation at the USAF Laser Hardened

Materials Program Review (LHMPR), National Institute of Science and Technology (NIST), Boulder, CO, August, 2003.

104) Irvin, G.E. *Interim Agile Night Vision Goggle Hardening Challenge II: Sensor Hardening for Optimum System Performance*. Invited presentation at the USAF Laser Hardened Materials Program Review (LHMPR), National Institute of Science and Technology (NIST), Boulder, CO, August, 2003.

105) Irvin, G.E. *Application of the Tristimulus Design Philosophy for Maximum Laser Eye Protection: Testing the Design and Materials Limits*. Invited presentation at the USAF Laser Hardened Materials Program Review (LHMPR), National Institute of Science and Technology (NIST), Boulder, CO, August, 2003.

106) Irvin, G.E. and Kuyk, T.K. *Mobium Capabilities and Experience Overview: Status of Current Research Initiatives in Laser Hardening*. Air Force Research Laboratories, Optical Radiation Branch, AFRL/HEDO, San Antonio, TX, April 22, 2003.

107) Irvin, G.E. *Interim Agile Night Vision Goggle Hardening Program Update: Prototype Characterization, Performance Modeling and Initial Flight Testing Results.* Invited presentation at the USAF AFRL/HEA Warfighter Readiness Research Division, Mesa, AZ, January 2003.

108) Irvin, G.E. *Air Force Laser Eye Protection Program: Operational Performance Design Characterization*. Critical Program Review, Air Force Laser Eye Protection Program, Rockwell Science Center, Thousand Oaks, CA., December 10, 2002.

109) Irvin, G.E. *Operational Value to Warfighter for Performance in Excess of Key Performance Parameters: Flight Engagement Modeling*. Critical Program Review, Air Force Laser Eye Protection Program, Rockwell Science Center, Thousand Oaks, CA., December 10, 2002.

110) Irvin, G.E. *Operational Value to Warfighter for Performance in Excess of Key Performance Parameters: Visual Acquisition Modeling*. Critical Program Review, Air Force Laser Eye Protection Program, Rockwell Science Center, Thousand Oaks, CA., December 10, 2002.

111) Irvin, G.E. *Tristimulus LEP Design Initiative: Theoretic Capabilities and Materials Science Limitations*. Laser Eye Protection Advanced Technology Demonstration Program Review. Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, November 22, 2002.

112) Irvin, G.E. *Aircrew Laser Eye Protection Final Design: Spectacle Lens, Sun Insert and Side Shield Components, Rationale and Characterization*. Critical Design Review, Air Force Laser Eye Protection Program, Kaiser Optical Systems, Inc., Ann Arbor, MI., November 20, 2002.

113) Irvin, G.E. *Interim Agile Night Vision Goggle Hardening Challenge.* Invited presentation at the USAF Laser Hardened Materials Program Review (LHMPR), National Institute of Science and Technology (NIST), Boulder, CO, July 2002.

114) Irvin, G.E. *Initial Operational Capability (IOC) and Full Operational Capability (FOC) Aircraft Integration Air Force Aircraft Compatibility Analysis.* Aircrew Laser Eye Protection (ALEP) System Design and Development Program (SDD) Test Plan Working Group (TPWG). Kaiser Optical Systems, Inc., Ann Arbor, MI., 20 April, 2002.

115) Irvin, G.E. *Visual Performance in the Mission Context, NVG Hardening Design Considerations*. Invited presentation at the Laser Hardened NVG Workshop, Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, March 12-14, 2002.

116) Irvin, G.E. *Night Vision Goggle Laser Hardening Goals: Comprehensive Flight Engagement - Laser Effects- Physiological Optics Modeling from Threat System to Retina*. Invited presentation at the Laser Hardened NVG Workshop, Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, March 12-14, 2002.

117) Irvin, G.E. *Air Force Laser Eye Protection Initiatives: LEP and Night Vision Design, Analysis and Measurement Final Report.* Laser Hardened Materials Advanced Studies (LHMAS), Air Force Research Laboratory, Materials and Manufacturing Directorate, February, 2002.

118) Irvin, G.E. and Johnson, W. *Laser Eye Protection Design Tools.* Air Force Scientific Advisory Board Review, Poster Session, Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, November 7, 2001.

119) Irvin, G.E. and Rea, E.J. *Aircraft Spectral Measurements, Final Report*. Submitted under: Laser Hardened Materials Advanced Studies (LHMAS), Spectral Embedding Methodologies Program, Submitted to: US Air Force Research Laboratory, Wright Laboratory, Electromagnetic Materials Division, Hardened Materials Branch (AFRL/MLPJ), and, Air Force Materiel Command, 311th Human Systems Program Office, 311 HSW/YACL. October 2, 2001.

120) Irvin, G.E. *Aircrew Laser Eye Protection Program Prototype Design Analysis and Characterization*. System Functional Review, Air Force Laser Eye Protection Program, Rockwell Science Center, Thousand Oaks, CA., August 22, 2001.

121) Irvin, G.E. *Aircrew Laser Eye Protection Program System Functional Review: Laser Threat/Mission Analysis and Assessment, and, ALEP System Design and Approach.* System Functional Review, Air Force Laser Eye Protection Program, Kaiser Optical Systems, Inc., Ann Arbor, MI., August 8, 2001.

122) Irvin, G.E. *The Design of Hybrid Absorptive and Reflective Eyewear for Laser Eye Protection.* Invited presentation and poster session at the USAF Laser Hardened Materials Program Review (LHMPR), National Institute of Science and Technology (NIST), Boulder, CO, July 2001.

123) Irvin, G.E. *Aircrew Laser Eye Protection Program Laser Eye Protection Design and Characterization,* and, *Aircrew Laser Eye Protection Program Threat/Mission Analysis and Studies*. Technical Interchange Meeting, Air Force Laser Eye Protection Program, Kaiser Optical Systems, Inc., Ann Arbor, MI., June 20, 2001.

124) Irvin, G.E. *Aircrew Laser Eye Protection Program Prototype Filter Characterizations and New Designs*. Test Plan Working Group, Air Force Laser Eye Protection Program, Boeing, St. Louis, MO., May 31, 2001.

125) Irvin, G.E. *Aircrew Laser Eye Protection Program Modeling and Analysis,* and, *Aircrew Laser Eye Protection Program Design Protection Requirements*. Preliminary Design Review, Air Force Laser Eye Protection Program, Kaiser Optical Systems, Inc., Ann Arbor, MI., April 25, 2001.

126) Irvin, G.E. *Aircrew Laser Eye Protection Program Prototype Filter Designs and Trades Studies*. Technical Interchange Meeting, Air Force Laser Eye Protection Program, Rockwell Science Center, Thousand Oaks, CA., April 11, 2001.

127) Irvin, G.E. *Laser Threat Definition and Mission Analysis*, and, *Laser Eye Protection Modeling and Analysis*. Preliminary Design Review, Air Force Laser Eye Protection Program, Kaiser Optical Systems, Inc., Ann Arbor, MI., Jan 24-25, 2001.

128) Irvin, G.E. *Air Force Laser Eye Protection (ALEP) Characterization and Optimization*. Preliminary Design Review, Air Force Laser Eye Protection Program, Rockwell Science Center, Thousand Oaks, CA., Jan 17-18, 2001.

129) Irvin, G.E. *Integrated Spectral Transmission Optimization Research Model (ISTORM), LEP Filter Design and Optimization*, Post Award Conference and Kick-off Meeting, Air Force Laser Eye Protection Program, Rockwell Science Center, Thousand Oaks, CA., Oct 11-12, 2000.

130) Irvin, G.E. *Laser Threat Analysis and Laser Eye Protection Filter Design and Optimization*, Post Award Conference and Kick-off Meeting, Air Force Laser Eye Protection Program, Kaiser Optical Systems, Inc., Ann Arbor, MI., Oct 5-6, 2000.

131) Irvin, G.E. *Integrated Spectral Transmission Optimization Research Model (I-STORM).* Invited presentation, poster session and demonstration at the USAF Laser Hardened Materials Program Review (LHMPR), National Institute of Science and Technology (NIST), Boulder, CO, August 2000.

132) Irvin, G.E., Irvin, J.G., Riccio, G.E., McDonald, P.V. and Skelly, J.J. *Advanced Human-Systems Technology for Uninhabited Aerial Vehicle (UAV) Ground Control Segments (GCS).* Laboratory Report. U.S. Air Force Research Laboratory, Human Effectiveness Directorate, Crew Systems Interface Division (AFRL/HECP). AFRL-HE-WP-TR-2000-0068, January 200.

133) Irvin, G.E. *Spectral Transmission Optimization Research Model (STORM)*. Poster Session and Demonstration at the Scientific Advisory Board Review, Air Force Research Laboratory, Materials and Manufacturing Directorate, Dayton, OH, December 2, 1999.

134) Irvin, G.E. *Technology Transfer and Applications from Industry-Academe Alliance*. Invited presentation Distributed Real-Time Sensors Program, Syracuse University, Computer Science Scalable Concurrent Programming Laboratory, October 20, 1999.

135) Irvin, G.E. *Integration of Absorptive and Reflective Technologies into Laser Eye Protection*. Invited presentation and Poster session at the USAF Laser Hardened Materials Program Review (LHMPR), National Institute of Science and Technology (NIST), Boulder, CO, August 1999.

136) Irvin, G.E. *Desired Laser Eye Protection Characteristics: Designing for Visual Performance*. Integrated Filter Technology Workshop, U.S. Air Force Research Laboratory, Airborne Survivability Group, Hardened Materials Branch (AFRL/MLPJ), Dayton, OH, November 17-19, 1998.

137) Irvin, G.E. *Integrated Filter Design: Spectral Transmission Optimization Research Model (STORM).* Integrated Filter Technology Workshop, U.S. Air Force Research Laboratory, Airborne Survivability Group, Hardened Materials Branch (AFRL/MLPJ), Dayton, OH, November 17-19, 1998.

138) Irvin, G.E. *Out-of-Band Laser Eye Protection Filter Designs*. Integrated Filter Technology Workshop, U.S. Air Force Research Laboratory, Airborne Survivability Group, Hardened Materials Branch (AFRL/MLPJ), Dayton, OH, November 17-19, 1998.

139) Irvin, G.E. *Fixed Filter Laser Eye Protection Designs*. Integrated Filter Technology Workshop, U.S. Air Force Research Laboratory, Airborne Survivability Group, Hardened Materials Branch (AFRL/MLPJ), Dayton, OH, November 17-19, 1998.

140) Irvin, G.E. *Flexible Filter Laser Eye Protection Designs*. Integrated Filter Technology Workshop, U.S. Air Force Research Laboratory, Airborne Survivability Group, Hardened Materials Branch (AFRL/MLPJ), Dayton, OH, November 17-19, 1998.

141) Irvin, G.E. *Tristimulus Filter Laser Eye Protection Designs*. Integrated Filter Technology Workshop, U.S. Air Force Research Laboratory, Airborne Survivability Group, Hardened Materials Branch (AFRL/MLPJ), Dayton, OH, November 17-19, 1998.

142) Irvin, G.E. *Laser Hardening with Enhanced System Performance*. USAF Laser Hardened Materials Program Review (LHMPR), National Institute of Science and Technology (NIST), Boulder, CO, September 1998.

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144) Irvin, G.E. *The Reflective Glare Model: Modeling the Effects of Absorptive Dyes on Reflective Glare for Laser Eye Protection (LEP) Filters.* Laboratory Report, U.S. Air Force Research Laboratory, Wright Laboratory, Materials and Manufacturing Directorate, Hardened Materials Branch (AFRL/MLPJ), LR-5403-3-1, 16pp, April 1998.

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146) Irvin, G.E. *Spectral Mapping: A Perceptual Components Approach to Exploitation of Multispectral Imagery*. American Society for Photogrammetery & Remote Sensing and Resource Technology Institute (ASPRS-RTI), Tampa, FL, April, 1998.

147) McDonald, P.V., Riccio, G.E., Irvin, G.E. & Bloomberg, J.J. *Multimodal Perception of Multicriterion Control of Nested Systems: II. Constraints on Crew Members During Space Vehicle Abort, Entry and Landing*. National Aeronautics and Space Administration, Lyndon B. Johnson Space Center, NASA TP-1998-3703v2, April, 1998.

148) Irvin, G.E. *Tristimulus Filter Design Issues*. USAF Laser Hardened Materials Program Review (LHMPR), National Institute of Science and Technology (NIST), Boulder, CO, August 1997.

149) Irvin, G.E., Gaska, J.P., Riccio, G.E. & Haaland, P.D. *Spectral Mapping of Indirect View Systems for Laser Hardening*. Invited Presentation Wright Laboratory Materials Directorate, Hardened Materials Branch (WL/MLPJ), Dayton, OH, June 1997.

150) Ramer, D.P., Irvin, G.E., Heaton, H.H. & Malek, D.A. *Multispectral Aerosol Obscurant Effects on Synthetic Aperture Radar Target Acquisition Study*. Proceedings of the

Smoke/Obscurants Symposium XIX: Vol.1. U.S. Army Chemical Research, Development and Engineering Center, ERDEC-TR-223, STC TR-3123, April, 1997

151) Irvin, G.E., Edmonds, B.P. *Tristimulus and Holographic Aircrew Laser Protective Eyewear: Field Testing and Compatibility Metrics.* Technical Report, Wright Laboratory Materials Directorate, Hardened Materials Branch (WL/MLPJ), Dayton, OH, October, 1996.

152) Irvin, G.E., Aleva, D.L., Gaska, J.P. & Jacobson, L.D. *Human Performance Aiding for Tactical Decision Aids and Mission Performance Aids: A Model of Human Visual Performance for the Weather Impact Decision Aid (WIDA) Electro-Optical Simulation (ACT/EOS).* Armstrong Laboratory, Crew Systems Directorate, Human Engineering Division, Systems Integration Branch, AL/CFHI, AL/CF-TR-1996-0121, March 1996.

153) Irvin, G.E., Gaska, J.P. & Jacobson, L.D. *Human Performance Model (HPM): A General Model of Human Visual Discrimination Developed to Predict Human-System Performance for use in Tactical Decision Aids and Mission Performance Aids*. Phillips Laboratory, Directorate of Geophysics, Air Force Material Command, Hanscom AFB, MA, PL-TR-95-2092, December 1995.

154) Irvin, G.E. Invited Panelist, Symposium Synopsis Discussion Panel. Sixth Annual Camouflage, Concealment and Deception Symposium, Revolutionizing CCD for the Next Century, American Defense Preparedness Association, Combat Survivability Division, U.S. Navy Fleet Combat Training Center Atlantic, Virginia Beach, VA., September, 1995.

155) Watts, K., Hogan, G. & Irvin, G.E. *Fourth Space Warning Squadron Survivability Improvement Program: Phase II Survivability Exercise Report* (U). Defense Weapons Systems Agency, Strategic Command and Control Division (DWSA/NASC), Technical Report DNA-TR-95-66, June 1995.

156) Irvin, G.E. & Riccio, G.E. *User-Centered Approach to Strategic Alliances for Technology Transfer from the Federal Laboratories*. Invited presentation at the NTTC Forum on Commercialization of Disability Technologies: Overseeing the Commercialization and Marketing Gaps. Sponsored by the National Technology Transfer Center, American Chemical Society, Washington, DC, and April 1995.

157) Irvin, G.E. & Heaton, H.H. *Human Performance Evaluation of the Effects of Multispectral Aerosol Obscurants on Synthetic Aperture Radar Target Acquisition and Designation*. Invited presentation at U.S. Army, Edgewood Research, Development and Engineering Center, Research and Technology, Modeling and Simulation Team (SCBRD/RTM), Aberdeen Proving Ground, MD, April 1995.

158) Doyal, J.A., Irvin, G.E. & Ramer, D.P. *Operator Cursor Positioning Performance on Navigational Update and Target Positioning Tasks: Evaluation of Gain Functions for the B-2 Radar-Embedded Cursor System* (U). Armstrong Laboratory, Crew Systems Directorate, Human Engineering Division, Crew Systems Integration Branch, AL/CFHI, AL/CF-TR-1995-0106, April 1995.

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160) Irvin, G.E. *Federal Technology Transfer for the Development of Assistive Technologies*. Invited presentation at the Improvement of Assistive Technology Devices for Home Care of Persons with Physical Impairments Conference, Sponsored by the Medical College of Wisconsin, Office of Research and Technology, and, Center for Biomedical Engineering and Biomathematics, Milwaukee, WI, June 1994.

161) Stengle, J.D., Heaton, H.H., Finch, S., Hopper, J., Irvin, G.E., Irvin, J.G., et. al. *Systems Engineering Design and Technical Analysis for Strategic Avionics Crew Station Design Evaluation Facility (SACDEF)* Armstrong Laboratory, Crew Systems Directorate, Human Engineering Division, Crew Systems Integration Branch, AL/CFHI-TR-1994-0074, May, 1994.

162) Irvin, G.E. *Toward a New Methodology for the Development of Assistive Technologies*. Invited presentation at the Forum on Technology Transfer and People with Disabilities, Sponsored by the National Technology Transfer Center, American Chemical Society, Washington, DC, March 1994.

163) Irvin, G.E., Wilson, D.L., Gaska, J.P. and Jacobson, L.D. *Human Performance Modeling and Analysis Program for Mission Planning Aids*. Weather Impact Decision Aids (WIDA) for Operation of Electro-Optical and Radio Frequency Systems, Requirements and Technical Interchange Meeting, Las Vegas, NE, March 1994.

164) Irvin, G.E. *Quantitative Methodologies for the Development and Evaluation of Camouflage Systems*. Visiting Scientists Invitational Colloquium, Headquarters U.S. Army, Belvoir Research, Development and Engineering Center, Night Vision and Electronic Sensors Directorate, Visionics and Image Signal Processing Division (AMSEL-RD-NV-D), Ft. Belvoir, VA, March 1994.

165) Irvin, G.E., and Wilson, D.L. *Tristimulus Laser Protection Concept Design: Human Centered Approach to Rugate Spectral Profiles*. Proceedings of the Sixteenth Annual Lasers on the Modern Battlefield Conference, Armstrong Laboratory School of Aerospace Medicine. San Antonio, TX, February 1994.

166) Irvin, G.E., Casagrande, V.A., Norton, T.T. *Center-Surround Relationships of Magnocellular, Parvocellular and Koniocellular Relay Cells in Primate Lateral Geniculate Nucleus*. Visual Neuroscience, 10, 363-373, 1993.

167) Irvin, G.E. *Technology Transfer for Developmental Disabilities*. Invited presentation to the Ohio Developmental Disabilities Planning Council, Columbus, OH, December 1993.

168) Irvin, G.E. *The Assistive Technologies Group Technology Transfer Initiative*. Forum on Technology Transfer for Developmental Disabilities. Sponsored by the Assistive Technologies Group at Wright State University, Dayton, OH, December 1993.

169) Irvin, G.E. & Wilson, D.L. *Texture Image Processing System for the Development and Evaluation of Multispectral Spatial Patterning*. Fourth Annual Camouflage, Concealment and Deception Symposium, CCD for Joint/Combined Contingency Operations, American Defense Preparedness Association, Combat Survivability Division, Eglin AFB, FL., October, 1993.

170) Irvin, G.E. *Ohio Consortium for the Development of Assistive Technologies*. Presentation by the Assistive Technologies Group to Federal Laboratory Consortium for Technology Transfer and Air Force Armstrong Laboratory. Dayton, OH, September, 1993.

171) Wilson, D.L. & Irvin, G.E. *Human Performance Modeling of Target Detection, Identification, and Recognition Ranges for Application in Tactical Decision Aids*. Fourth Annual Ground Target Modeling and Validation Conference, U.S. Army Tank-Automotive Research, Development and Engineering Center, and, U.S. Army Belvoir Research, Development and Engineering Center. Warren, MI, August 1993.

172) Irvin, G.E. *The Future Threat from Precision Guided Weapons and Strategies for Defeat by Advanced Optical Modulation Techniques*. Laser Countermeasures Program IPR, Defense Nuclear Agency and Aeronautical Systems Division, Air Base Operability and Survivability Branch (ASC/YQ), Eglin Air Force Base, August, 1993.

173) Irvin G.E. *Vision Research in the Department of Defense*. Visiting Scholars Program Invitational. Vision Science Research Center, School of Optometry Department of Physiological Optics, University of Alabama at Birmingham, AL, April, 1993.

174) Irvin G.E., Doyal J.A. & Koch R.D. *Experimental Approach to the Evaluation of Radar Obscurant Requirements for Effective Disruption of Air-to-Ground Target Acquisition*. Proceedings of the Smoke/Obscurants Symposium XVII: Early Entry Survivability. U.S. Army Chemical and Biological Defense Agency, Edgewood Research, Development and Engineering Center, Research and Technology Directorate, Vol. 1, pp. 171-183, 1993.

175) Irvin G.E., Jacobson L.D. & Gaska J.P. *Human Performance Modeling to Improve Tactical Decision Aid Ranging Algorithm Predictions*. Electro-Optical Tactical Decision Aid Conference, Las Vegas, NE., March, 1993.

176) Dowler, M.G. & Irvin, G.E. *Visual Psychophysical Testing of the Advanced Vision Concepts Program Laser Protective Eyewear*. Proceedings of the 15th Annual Lasers on the Modern Battlefield. San Antonio, TX, February, 1993.

177) Irvin, G.E. *Joint Camouflage, Concealment and Deception (JCCD) Joint Test and Evaluation Program Test Design*. Office of the Secretary of Defense, Under Secretary of Defense, Acquisition, (OSD USD(A)), Weapons Systems Assessment, Special Test and Evaluation Program (WSA/STEP), 126 pp., September 1992.

178) Irvin, G.E. and Dowler, M.G. *Modeling Requirements for Human Performance Evaluation Metrics for Airborne Tactical Decision Aids: Pyramidal Representations, and, Adaptive Luminance and Contrast Gain Control*. Invited Presentation, Wright Laboratory, Avionics Directorate, (WL/AARI), Dayton, OH, September, 1992.

179) Irvin, G.E. *Multimedia Information Analysis Procedures for a New Fiducial Aimpoint Scoring Methodology to Support Air-to-Ground Multispectral Target Acquisition Field Testing using the Global Positioning Systems (GPS) based Tactical Air Combat Training System (TACTS)*. Invited Presentation at Headquarters, Joint Camouflage, Concealment and Deception Joint Test and Evaluation Program (JCCD), Vicksburg, MS, September, 1992.

180) Irvin, G.E., Gaska, J.P. and Jacobson, L.D. *Joint Space/Spatial Frequency Representation Architectures to Support Prediction of Airborne Visual Detection, Identification and Recognition Ranges of Complex Target Classes in Complex Backgrounds*. Invited Presentation at Phillips Laboratory, Geophysics Directorate, Atmospheric Sciences Division (PL/PGA), May, 1992.

181) Irvin, G.E., Dowler, M.G. *Physiological-Based Computational Approach to Camouflage and Masking Patterns*. Automatic Object Recognition II, Psychophysics for Easier Pattern

Recognition, SPIE Symposium on Optical Engineering and Photonics in Aerospace Sensing, Vol. 1700, pp. 481-488, April, 1992.

182) Irvin, G.E. *Program Test Design Architecture for the Fixed Facility Joint Camouflage, Concealment and Deception Joint Test and Evaluation Program*. Joint Test and Evaluation Working Group Meeting, Reno, NV, February, 1992.

183) Donohue, T.R., Irvin, G.E., Doyal, J.A. & Dowler, M.G. *Creek Shadow Camouflage, Concealment and Deception (CCD) Demonstration Final Report: Experimental Results and Complete Data Bases of Pilot Questionnaires, Radar Bomb Scoring and Head-Up Display Imagery and Voice Analysis*. Armstrong Laboratory, Crew Systems Directorate, Human Engineering Division, Crew Systems Integration Branch, AL/CFHI, CCD-ILR-92:01, 1992. (UNCLASSIFIED).

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185) Irvin, G.E. *Visual Detection Simulator: A Physiologically Based Computational Approach to Human Visual Threshold Prediction*. Invited presentation at USAF Human Systems Division Armstrong Laboratory Advisory Group Conference on Applied Spatial Vision Models for Target Detection and Recognition. San Antonio, TX., March 1991.

186) Irvin, G.E., Keep, G.F., Dowler, M.G. *2-Dimensional Aircraft Decoys Based on Perspective Rendition: Overview and Experimental Results*. Aerospace Medical Association, Cincinnati, OH., May 1991.

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199) Irvin, G.E. & Kang, R.N. *Perimetry Measures of Transient Visual Field Loss in the Presence of Foveal Laser Exposures in Humans (U)*. Sixth DoD Conference on Directed Energy Weapons: Vulnerability, Survivability and Effects. Joint Technical Coordinating Group on Aircraft Survivability. National Bureau of Standards, Gaithersburg, MD, May 1987, (Secret).

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206) Irvin, G.E. *The Primate Superior Colliculus; the Functional Implications of our Current Understanding of Anatomy, Physiology, and Psychophysics*. Invited Lectures (two), Current Topics in Optometry and Visual Science, Vision Science Research Center, School of Optometry Medical Center, University of Alabama in Birmingham, May, 1984.

207) Irvin, G.E. *Neurophysiological, Anatomical, and Psychophysical Basis of On- and Off-center Mechanisms in the Mammalian Visual System and their Implications for Current Theoretical Models of Visual Information Processing*. Invited Lecture, Current Topics in Optometry and Visual Science, Vision Science Research Center, School of Optometry, The Medical Center, University of Alabama in Birmingham, April, 1984.

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BEFORE THE ENERGY RESOURCES CONSERVATION AND DEVELOPMENT COMMISSION OF THE STATE OF CALIFORNIA
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APPLICATION FOR CERTIFICATION For the *PALMDALE HYBRID POWER PROJECT*

Docket No. 08-AFC-9

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(Revised 1/14/2011)

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DECLARATION OF SERVICE

I, Rhea Moyer, declare that on, February 4, 2011, I served and filed copies of the attached Energy Commission Staff's Pre-Hearing Conference Statement, dated February 4, 2011. The original document filed with the Docket Unit is accompanied by a copy of the most recent Proof of Service list, located on the web page for this project at: [http://www.energy.ca.gov/sitingcases/palmdale/index.html]. The document has been sent to both the other parties in this proceeding (as shown on the Proof of Service list) and to the Commission's Docket Unit, in the following manner:

(*Check all that Apply*)

FOR SERVICE TO ALL OTHER PARTIES:

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Attn: Docket No. 08-AFC-9
1516 Ninth Street, MS-4
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I declare under penalty of perjury that the foregoing is true and correct, that I am employed in the county where this mailing occurred, and that I am over the age of 18 years and not a party to the proceeding.

/s/ Rhea Moyer

Rhea Moyer