FUNDING OPPORTUNITY DESCRIPTION

IARPA often selects its research efforts through the BAA process. The use of a BAA solicitation allows a wide range of innovative ideas and concepts. This BAA technical draft is for the EQuAL-P program. When released, the full BAA will appear on https://sam.gov/, the official U.S. Government website for federal awards, and a link to the BAA will appear on the IARPA website at http://www.iarpa.gov/. The following information is for those wishing to respond to this Program BAA.

1. A. Program Overview

The Intelligence Community (IC) and the Department of Defense (DoD) missions often require the use of electrically small antennas (ESAs) where the size of the antenna is significantly smaller than the wavelength of operation, fundamentally limiting the antenna performance. The Effective Quantitative Antenna Limits for Performance (EQuAL-P) program aims to realize significant gains in the performance of ESAs by employing active and/or time varying solutions.

Of particular relevance to the IC and DoD, is the product of antenna bandwidth (β) and radiation efficiency (η) for many operations involving radio frequency (RF) transmission and reception. This BAA uses the definition of electrical smallness given by $ka < ½$ where k is the operational wavenumber and a corresponds to the radius of the imaginary Chu sphere enclosing the antenna [1]. In some transmit (Tx) and receive (Rx) applications, the electrical size of an antenna may limit its ability to operate at multiple carrier frequencies, to handle wideband signals (e.g., direct sequence spread spectrum) without distortion, and/or to support higher data rates as described by the well-known Shannon limit for channel capacity. It is well known that antenna bandwidth may be increased at the expense of radiation efficiency, but this tradeoff is often problematic for many operations. In the case of some transmit operations, the overall system efficiency may be critical due to limited available power or energy or due to limitations for heat exchange meant to keep the system cool and linear. For both Rx and Tx, the need to optimize the signal to noise ratio (SNR) is also often critical especially in noisy environments. EQuAL-P seeks transmit solutions that are "plug-in" efficient with values of η effectively equal to 50% or higher, although lower levels might be acceptable especially for $ka << 1$. When operating in receive mode in an internally noise-limited environment, system sensitivity is often critically dependent on radiation efficiency. In general, many operations require ESAs to operate with $\beta\eta$ greater than the limit physics imposes on them. In particular for linear, time invariant (LTI) antennas

$$\beta\eta \leq \frac{1}{\sqrt{2}}\left(\frac{1}{ka} + \frac{1}{n(ka)^3}\right)$$

where n is the number of independent radiating modes, limited to one or two [2]. The proportionality constants in this formula depend on what definition of impedance bandwidth is chosen, in this case with the voltage standing wave ratio (VSWR) set to two or less.

This limit appears to be immutable. Therefore, it is anticipated that passive, time-invariant solutions will not be successful in accomplishing the aims of the program. However, if the operational reasons for improving $\beta\eta$ are considered, it may be possible to realize significant gains in an effective bandwidth-radiation efficiency product by employing active and/or time varying solutions, thereby circumventing the assumptions the fundamental performance limits are based upon. Solutions will likely depend on the frequency of operation. EQuAL-P contemplates operation in the high frequency (HF), very high frequency (VHF), and ultrahigh frequency (UHF) bands.

Beyond the size of the antenna itself, some techniques for enhancing $\beta\eta$ may rely on additional hardware potentially increasing the overall system size, power demands, and system infrastructure. Examples of this might be employing a cryogenically cooled field-sensing element or switching systems requiring a full rack of supportive circuitry. While such techniques may very well have merit for certain applications, the aim of the EQuAL-P program is to develop techniques that minimally add to the overall system size, power draw, and hardware required for operation; Offerors should comment on these factors in their proposals.

Additionally, EQuAL-P aims to deliver solutions that are "benchtop compatible" in the sense that they can be implemented on a student's lab bench *mostly* with the standard tools (e.g., soldering irons, printed circuit board milling machines) of a typical university antenna lab. Offerors should stipulate any specialized equipment required for implementation and the cost as a potential barrier to implementation. Beyond electrical size (defined by $ka < \frac{1}{2}$), EQuAL-P prefers antenna sizes restricted to $a < 1.0$ meter, recognizing that some HF applications afford additional space with a as large as 5 meters. In many operations, ground planes of various electrical size are often incidentally present, form part of the resonant structure, and strictly speaking, enlarge the antenna beyond the resonant element [3]. In recognition of this tendency, EQuAL-P expresses a preference for techniques that are consistent with radiating elements over or close to ground planes. Additionally, many operations do not afford space for antennas with spherical geometries or aspect ratios close to one. In recognition of both tendencies, EQuAL-P expresses the preference for techniques that are consistent with planar radiating elements and recognizes that the $\beta\eta$ limit for such geometries must be calculated appropriately for ground plane size and occupied volume. These geometrical limits are sometimes referred to as the Gustafsson limit [4] and are typically significantly lower than the Chu limit.

EQuAL-P recognizes that some offered techniques may be applicable to a single modulation scheme or to a small set of modulation types. While such narrowly applicable techniques are of interest, techniques that can be applied with high fidelity to a broad set of modulation schemes or at least to very common ones are preferred. Phase modulation is one important modulation type. The ability to reconfigure the modulation in real-time operation just like a "normal" antenna would react to whatever modulation is presented at its input would be acceptable. Offerors should address these issues in their proposal.

EQuAL-P seeks systems that allow both transmit and receive capabilities but will consider proposals that offer just one of these capabilities.

Finally, solutions must be reasonably durable against environmental and operational variations. Offerors should address issues of performance stability due to changes in the environment and the ability to work over a wide range of transmit power and background noise.

While non-Foster matching is a well-known technique for increasing effective antenna bandwidth, approaches based strictly on that principle will not be considered in this BAA.

1. A.1. Technical Challenges

Proposals must fully describe the Offeror's technical approaches to addressing some or all of the following Technical Challenges (TCs). All proposals must address TC-1.

1. TC-1 – effective limits of proposed techniques

   The EQuAL-P objective for TC-1 is to project or establish the limits of the technique(s) being proposed to the effective bandwidth-efficiency product and to characterize other limitations of the technique (e.g., linearity with power, stability, emission of harmonics).

2. TC-2 – operational prototype for transmit

The EQuAL-P objective for TC-2 is to demonstrate an operational prototype able to transmit with an effective bandwidth-efficiency product superior to what is achievable with a traditional ESA (to be determined by the government) by at least 10 dB. For transmit, target center frequencies should be either 10 MHz, 100 MHz, 300 MHz, and/or 1 GHz.

3. TC-3 – operational prototype for receive

   The EQuAL-P objective for TC-3 is to demonstrate an operational prototype able to receive with an effective bandwidth-efficiency product superior to what is achievable with a traditional ESA (to be determined by the government) by at least 10 dB. For VHF and UHF receive, target center frequencies should be 100 MHz, 300 MHz, and/or 1 GHz. The entire HF frequency band (3-30 MHz) should be covered by HF receive non-LTI prototype systems.

4. TC-4 – operational prototype for dual transmit/receive

   The EQuAL-P objective for TC-4 is to demonstrate an operational prototype able to receive with an effective bandwidth-efficiency product superior to what is achievable with a traditional ESA (to be determined by the government) by at least 10 dB. Target center frequencies should be 100 MHz, 300 MHz, and/or 1 GHz. The entire HF frequency band (3-30 MHz) should be covered by HF receive non-LTI prototype systems.

1. A.2. Program Phases

The EQuAL-P program will proceed in three phases. The phases are designed to give Performers time to explore potentially more speculative solutions early on while requiring operational prototypes in Phases II and III. More detail can be found in SECTION 1. F. Program Metrics. The following paragraphs introduce the phases.

Phase I – Extensibility: Phase I will last 18 months and will focus on the viability of the Performer's proposed approach. Performers are required to provide compelling experimental, analytical, or modeling evidence that their approach will result in a working prototype capable of achieving 10 dB improvement in the effective bandwidth-efficiency product of an otherwise equivalent ESA. Exercise of the option to continue with the EQuAL-P program into Phase II will consider a thorough, independent evaluation of the Performer's presented evidence.

Phase II – Initial Prototype: Phase II will last 15 months and will focus on the development of a functional prototype capable of achieving 6 dB improvement in the effective bandwidth-efficiency product of an equivalent ESA. Exercise of the option to continue with the EQuAL-P program into Phase III will consider independent measurements to validate non-LTI antenna performance.

Phase III – Final Prototype: Phase III will last 12 months and will focus on the development of a functional prototype capable of achieving 10 dB improvement in the effective bandwidth-efficiency product of an equivalent ESA.

1. B. Team Expertise

Collaborative efforts and teaming among Offerors are highly encouraged. It is anticipated that Offeror teams will be multidisciplinary and may include expertise and experience in multiple fields related to the EQuAL-P program goals.

1. C. Program Scope and Limitations

Proposals shall explicitly address all of the following:

- **Underlying theory:** Proposed strategies to meet program-specified metrics must have firm theoretical bases that are described with sufficient detail that reviewers will be able to assess the viability of the approaches. Proposals shall properly reference previous work upon which their approach is founded.

- **Development approach:** Proposals shall describe the technical approach to meeting program metrics.

- **Technical risks:** Proposals shall identify technical risks and proposed mitigation strategies for each.

- **Team and Program Management and Internal Testing and Evaluation:** Proposals shall describe the approach to leveraging and managing the contributions of each member of the Offeror team and the approach to testing and evaluation (T&E) of the developed techniques independently from IARPA's T&E.

The following areas of research are out of scope for the EQuAL-P program:

- Research that does not have strong theoretical and experimental foundations.

- Research that does not have plausible scientific support for the proposed results.

- Development of conventional amplifier hardware. New or novel applications of amplifier hardware are acceptable.

- Research into software techniques that are generally applicable to signal reconstruction; software techniques that are specifically applicable to an Offeror's approach may be acceptable.

- Non-Foster approaches.

1. D. Theory

Achieving program metrics will require Performers to develop experimental, analytical, or modeling evidence that their approach will result in a working prototype capable of achieving 10 dB improvement in the effective bandwidth-efficiency product of an otherwise equivalent ESA. It is anticipated that Performers will have to advance the state-of-the-art theoretical understanding of time-varying antennas throughout the lifetime of the program and particularly so in Phase I.

1. E. Test and Evaluation (T&E)

IARPA research programs include rigorous, objective evaluations aimed at demonstrating achievement of carefully designed technical performance metrics. This section describes plans for the test and evaluation protocols to which Performer deliverables will be subjected. Performers will be informed as T&E plans are refined or otherwise revised as the program progresses.

1. E.1. Effective Performance Parameters

Measurement techniques for β and η of traditional LTI antennas has been very well established. However, when considering the performance of a non-LTI antenna design for practical operation, the comparison to an LTI antenna is not necessarily straightforward. This BAA sets forth a test framework to allow for the calculation of effective performance parameters as a basis for comparison. These parameters will depend on whether the antenna is working in transmit or receive mode. To validate T&E measurements of non-LTI antenna systems, IARPA plans to incorporate side-by-side measurements of LTI antenna systems of known bandwidth and efficiency for comparison.

It is anticipated that non-LTI approaches that are proposed will result in a larger effective system volume compared to the analogous LTI design. As a consequence, the effective *ka* of the system will be increased. The volume added may be in a different spatial location than the antenna itself. In such a case for a practical consideration, the circuit volume and any hardware supporting the circuit would have to be accommodated in the platform where the antenna resides. One way to account for this would be to add the extra hardware volume to the antenna volume as a simple sum, but there may be advantages to approaches where the volumes are essentially separate or independent. Proposers should describe the physical volume the time-varying hardware will occupy compared to *ka* (or the relevant Gustafsson geometrical shape for non-spheres). To facilitate evaluation of the utility of the Offeror's technique, a comparable ESA with state-of-the art performance should be proposed.

1. E.2. Transmit

One approach for determining effective bandwidth (β_{eff}) is to consider the bandwidth of the waveform to be transmitted. If the resulting transmitted signal is transmitted with an error vector magnitude (EVM) equivalent to an SNR degradation of less than 1 dB for an equivalent bandwidth LTI system, the non-LTI antenna system has effectively achieved the bandwidth of the waveform. As the waveform bandwidth is increased, the received EVM presumably increases until the threshold is exceeded; this point determines the bandwidth of the non-LTI bandwidth antenna system. As previously stated, efficient operation in noisy environments is desirable.

Another approach for determining effective bandwidth (β_{eff}) is to consider the channel capacity of the communication system, which in principle would be limited by the ESA. This BAA recognizes that calculation of channel capacity depends on available SNR. Offerors should take this into account when describing the ultimate utility of their proposed technique. For example, it may be the case that the proposed technique only supports a particular modulation that indeed outperforms the ESA when transmitting that same waveform, but the ESA may be able to support a different, higher order modulation scheme than the non-LTI antennas with a higher channel capacity. Measurement of bit error rate (BER) may be necessary to validate performance in such cases. At least for transmit, it is assumed that optimal solutions will require highly efficient radiation and effective impedance match to the non-LTI antenna.

One approach for determining effective radiation efficiency (η_{eff}) is to consider the total power dissipated by the non-LTI system at typical FCC power transmission levels. In practical applications, any additional power consumed or dissipated by non-radiating elements will reduce the lifetime of an energy-constrained system and may limit the radiated power and thus the SNR as seen by a distant receiver for a power-limited system. Simply tallied, the power consumed by the non-LTI hardware is added to the power dissipated as heat in the radiating element when calculating efficiency:

$$\eta_{\text{eff}} = P_{\text{rad}}/(P_{\text{rad}} + P_{\text{dis}})$$

It is noted that for non-LTI systems, η_{eff} may be a function of total power available. Proposers should describe the impact of their approach on the effective radiation efficiency.

Non-LTI antenna systems may result in unwanted radiation beyond what is intentionally radiated. This can be particularly problematic in receive systems. Offerors should address this issue and mitigation strategies.

1. E.3. Receive

Similar to transmit, a possible approach for determining effective bandwidth (β_{eff}) of a non-LTI receive system is to consider the bandwidth of the waveform to be received with an EVM equivalent to an SNR degradation of less than 1 dB for an equivalent bandwidth LTI system. This approach may find applicability when the center frequency, bandwidth, and modulation type of the waveform to be received are exactly known. In this case, β_{eff} can be defined as it was before for transmit.

Similarly, the channel capacity of the receive non-LTI antenna could be considered, and the considerations of transmission may still apply. Additionally, this BAA notes that the optimal solution may not be a 100% efficient, perfectly impedance matched ESA depending on the available SNR. This is particularly true for high SNR environments. Offerors should take this into account when describing their technique and assume that optimal operation in low SNR environments is preferred.

A more common receive application involves detecting waveforms of various modulation types over a frequency range typically much larger than the bandwidth of any one waveform. For LTI antennas, both bandwidth and radiation efficiency are reciprocal quantities (i.e., the same for transmit and receive) and are most relevant when considering resonant antennas. In this latter case, bandwidth corresponds to the frequency range over which waveforms can be detected and with what efficiency and sensitivity. A receiver noise figure (or environmental noise level in the case of HF) will be used to compare across antennas, and an antenna should not appreciably increase the noise figure unless that increase in noise trades off for some other factor such as larger bandwidth or smaller size, weight, and power (SWaP). Presumably in both these cases, non-LTI circuitry will add to the power consumed by the antenna system. Similar to the transmit case, any additional power required by the receive system may reduce the lifetime of the system or exceed the available power, and in terms of the transduced or detected power (P_{det}) and dissipated power (P_{dis}), the effective efficiency may be expressed as

$$\eta_{\text{eff}} = P_{\text{det}}/(P_{\text{det}} + P_{\text{dis}})$$

In the cases described above, large efficiencies translate to higher SNR if the system is internally noise limited, and bandwidth typically translates to the frequency range over which signals can be received. When resonant antennas are simply too small to achieve useful bandwidth such as is typical at HF, non-resonant antennas are often employed. In this last case, common metrics are sensitivity or minimum detectable signal, but these may vary considerably with frequency over the operating band, and the radiation efficiencies of the non-LTI antennas are quite poor. With this in mind, Offerors should detail how their approach would outperform traditional systems where radiation efficiencies tend to be very low and/or external noise tends to be much greater than system noise. As a proxy for radiation efficiency in this case, the overall power draw of the system should be described in comparison to traditional state-of-the-art approaches. In a similar manner, sensitivity as a function of frequency should be described as a proxy for bandwidth.

1. F. Program Metrics

Achievement of metrics is a factor taken into account when determining whether to exercise options to continue performance under IARPA research contracts. IARPA has defined EQuAL-P program metrics to evaluate effectiveness of the proposed solutions in achieving the stated program goal and objectives, and to determine whether satisfactory progress is being made to warrant continued funding of the Performers. The metrics described in this BAA are shared with the intent to scope the effort, while affording maximum flexibility, creativity, and innovation to Offerors proposing solutions to the stated problem. Proposals with a plan to exceed the defined metrics in one or more frequency band are desirable. It is anticipated that specific T&E protocols including specific test equipment will be established at program Kick-off or shortly thereafter. Program metrics may be refined or further specified during the three phases of the EQuAL-P program; if metrics change, revised metrics will be communicated in a timely manner to Performers. In the previous section, the program metrics in terms of effective bandwidth and effective radiation efficiency have been described, but these might not be the best way to characterize these quantities.

This BAA puts forth reasonable definitions of effective bandwidth and efficiency for transmit systems, but there may exist others that are appropriate for alternative approaches not contemplated by the BAA. It is acceptable for Offerors to propose alternative definitions, so long as such definitions are appropriately constructed, defensible, and described in their proposal. Such definitions will be evaluated in tandem with proposed techniques. In any case, EQuAL-P will rely on the expertise of government and/or trusted agent (e.g., Federally Funded Research Development Centers, University Affiliated Research Centers) to independently measure the effective performance parameters as previously discussed, to refine measurement protocols as necessary, and to normalize amplifier and other equipment appropriately for a side-by-side comparison test between the device under test and a LTI system of similar size. Although not explicitly captured in the metrics, cost and size are of secondary consideration.

A summary of the metric targets by phase is shown in Table 1. Metric targets provided in Table 1 are preliminary and subject to change over the course of the program.

Table 1: EQuAL-P Program Metrics and Related Targets by Phase

Metric	Metric Target		
	Phase I	Phase II	Phase III
$\beta_{eff}\eta_{eff}$ (non-LTI ESA)	Provision of compelling experimental, analytical, or modeling evidence that approach will result in a working prototype capable of achieving 10 dB improvement in the effective bandwidth-efficiency product of an otherwise equivalent ESA.	Demonstration of a functional prototype capable of achieving 6 dB improvement in the effective bandwidth-efficiency product of an equivalent ESA.	Demonstration of a functional prototype capable of achieving 10 dB improvement in the effective bandwidth-efficiency product of an equivalent ESA.
η_{eff} (non-LTI ESA)	Initial projection of η_{eff} for the proposed technique.	Improvement toward final prototype goal.	η_{eff} > 50% for final prototype (unless *ka* << 1 at IARPA's discretion).
ka_{eff} (non-LTI ESA)	Evaluation of the effective volume of the non-LTI system. Projection of achievable miniaturization for future prototypes with ka_{eff} < ½.	Improvement toward final prototype goal.	ka_{eff} < ½ for final prototype.
$\beta\eta$ (Comparable LTI ESA)	Validation via measurement of the performance of the proposed, comparable ESA approaching its fundamental geometrical limit.	Improvement of validation, if necessary, as determined by IARPA.	Improvement of validation, if necessary, as determined by IARPA.

1. G. Program Waypoints, Milestones, and Deliverables

Waypoints are the means by which the Performer clearly demonstrates the quantitative and timely progress that must be made for the overall concept to meet end-of-phase milestones. In other words, the intent of waypoints is to provide a clear measure of progress towards meeting the program milestones so the PM and advisors can provide more effective guidance and assistance to the Performers. Performance against these waypoints will be reviewed throughout the program, and the PM and non-government advisors will use performance against the waypoints to assess whether course corrections are needed to ensure program success.

1. G.1. Required Program Waypoints

The Government has identified the waypoints listed below for all Performers.

Waypoint 1: Preliminary Design Review (PDR). A PDR will occur during the first site visit (to be held virtually if Covid19 restrictions preclude in-person visits), expected within the first four (4) months of contract award. The PDR must include documentation of the preliminary design and implementation plan, an accurate program schedule, and a mitigation plan for identified risks. At the PDR, Performer progress, plans, proposed workflows will be presented by the Performer team and assessed by the Government with input from the T&E team and selected advisors. The PM will document any deficiencies in what was presented by the Performer at the PDR or within three (3) business days thereafter. The exit criteria for the Critical Design Review (CDR) will be discussed at the PDR. The PM may also refine the Exit Criteria for the CDR as part of the PDR documentation following the PDR.

Waypoint 2: Critical Design Review (CDR). A CDR will occur during a site visit to the Performer site within nine (9) months of the contract award. At the CDR, Performer progress, final plans, and workflows will be presented by the Performer and assessed by the Government PM, with input from the T&E team and selected advisors. The Performer will provide evidence that all CDR Exit Criteria have been met. The PM will document any deficiencies in what was presented by the Performer at the CDR or within three (3) business days thereafter. As a required deliverable for the CDR, Performers must provide a demonstration by Phase III that their approach will result in a working prototype capable of achieving 10 dB improvement in the effective bandwidth-efficiency product of an otherwise equivalent ESA. Performers should expect IARPA to elaborate on the specific requirements for CDR and the CDR Exit Criteria at the time of the PDR or before.

Offerors are encouraged to propose additional waypoints to quantify how their individual systems support the broader goals of the program. Well-constructed Offeror-defined waypoints provide task-driven intermediate steps towards meeting program technical metrics based on the Offeror’s approach. Quantitative waypoints, reflected in the work plan and depicted on the schedule, help indicate progress toward milestones and reduce program risk by providing evidence that the technical and programmatic risks associated with the proposed approach are being addressed. A schedule of waypoint reviews must be included in proposals and shall include a rationale, definition, metrics, and an evaluation plan for each waypoint. Waypoint reviews may coincide with site visits, reviews at Government locations, and design reviews.

Government-defined program waypoints, milestones, and metrics may be refined during the various phases of EQuAL-P; changes will be communicated to Performers as quickly as possible.

1. G.2. Program Milestone Timeline and Deliverables

Table 2 shows a timeline for the program with Government-defined waypoints, milestones, and deliverables.

Table 2: Program Waypoint, Milestone, and Deliverables Timeline

Event	Deliverables	Months after Kick-off			Comments
		Phase I	Phase II	Phase III	
Program Kick-off	Performers attend kick-off workshop.	0-2	optional	optional	Informs Performers of other potentially relevant technical approaches.
PM Visits Performer Sites	Report on Action Items resolution from previous site visits and Action Item Closure Plans.	required: 4, 9, 15 PM option: 6, 12, 18	required: 21 & 27 PM option: 24 & 30	required: 33 & 39 PM option: 36 & 42	Present program progress and results of internal testing.
Preliminary Design Review (PDR)	Must include: Preliminary design documentation and implementation plan. Accurate program schedule. Mitigation plan for identified risks. Validation via measurement of the performance of proposed, comparable LTI ESA in relation to its fundamental geometrical limit.	4, coin-cides with first PM Visit			Present preliminary experimental, analytical, or modeling evidence that approach will result in a working prototype capable of achieving 10 dB improvement in the effective bandwidth-efficiency product of an otherwise equivalent ESA. PM to refine Exit Criteria for CDR.
Critical Design Review (CDR)	Must include: Updated design documentation and implementation plan. Critical/Final design documentation and implementation plan. Refined program schedule. Mitigation plan for identified risks. Results of internal tests. Proof Exit Criteria have been met.	9, coincides with PM Visit			The PM will identify potential deficiencies at the CDR or within three (3) business days thereafter and evaluate proof that Exit Criteria have been met.
PI Workshop	Presentations, Action Items, and Action Item Closure Plans.	11-12	25-27	38-40	Performers report on progress.
Test & Evaluation	T&E teams present evaluation results to the PM.	15-17	30-32	42-44	T&E teams evaluate Performer approaches (Phase I) and/or measure

					Performer hardware (Phases I-III).
End of Phase	Final Report as approved by PM.	18	33	45	All deliverables due.

In addition to scheduled deliverables shown in Table 2, the Government anticipates receiving the following as deliverables throughout the program (note that this list is not inclusive and is provided here as guidance for the Offerors). The award instrument type may alter this list.

- Any technical papers covering work funded by EQuAL-P;
- Monthly technical status reports detailing progress made, tasks accomplished, major risks, planned activities, trip summaries, changes to key personnel, and any potential issues or problem areas that require the attention of EQuAL-P Program Management shall be due within 10 days after the end of each month;
- Monthly financial status reports shall be due no later than 10 calendar days after the close of the invoice/billing cycle period covered by the report;
- A final report for each program phase that concisely describes and summarizes the work conducted, technical achievements, and remaining technical challenges, shall be due one calendar month after the end of each phase; and
- A final summary report shall be due at the end of the overall period of performance.

1. H. Meeting and Travel Requirements

Offerors are expected to assume responsibility for administration of their projects and to comply with contractual and program requirements for reporting, attendance at program workshops, and availability for site visits. In-person events will be held as allowed by evolving Covid19 restrictions. The following paragraphs describe typical expectations for meetings and travel for IARPA programs as well as the contemplated frequency and locations of such meetings. In addition to ensuring that all necessary details of developed designs, approaches, and prototypes, each Performer will be required to be available for questions and troubleshooting from each T&E team in weekly and/or bi-weekly status meetings.

1. H.1. Workshops

The EQuAL-P program intends to hold a program kick-off workshop in the first month of the program and then similar workshops annually thereafter. The dates and locations of these meetings are to be specified at a later date, but for planning purposes, Offerors should use the approximate times and locations listed in Table 2. These workshops will typically be of a two-day duration, will be held in the Washington, D.C. metropolitan area, and will focus on technical aspects of the program and on facilitating open technical exchanges, interaction, and sharing among the various program participants. Program participants will be expected to present the technical status and progress of their projects to other participants and invited guests. Individual sessions for each Performer with the Government Team will also be scheduled to coincide with these workshops.

1. H.2. Site Visits

Site visits by the Government Team including T&E performers and selected non-government advisors will generally take place up to four times yearly during the life of the program. These visits will occur at the Performer's facility. In addition to traditional means of conveying information such as reports and briefs on technical progress, details of successes and issues, and contributions to the program goals, Performers will be required to provide live, and interactive technology demonstrations, as appropriate.

1. H.3. Technical Status Meetings

The PM will be in frequent communication, in person or by teleconference, with Performers including both Prime and Subcontractors. Offerors should plan for a minimum of bi-weekly teleconference calls of one hour in duration. The frequency of these calls may change at the discretion of the IARPA PM.

1. I. Place of Performance

Performance will be conducted at the Performers' sites, with the exception of the tests at the end of each phase, which will occur at IARPA established testing sites.

1. J. Period of Performance

The EQuAL-P program is envisioned as a 45-month effort that is intended to begin July 2022. Phase I – Base Period of the program will last 18 months; Phase II – Option Period 1 will last 15 months; and Phase III – Option Period 2 will last 12 months.

1. K. Bibliography

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