ISSUE: Should the NRO acquire an interim system with improved imagery response time prior to EOI? If so, what is the desired system approach and what is to be the funding source?

Summary:

Since the January ExCom, the NRO field organizations have mounted an extensive investigation and evaluation of interim system concepts. Simultaneously, the United States Intelligence Board has directed an extensive effort in defining the interim system intelligence requirements against which the system concepts could be evaluated. As the interim system intelligence requirements took shape, it became evident that there were no "quickie" cheap system concepts which could satisfy the requirements.

The NRO analysis of system capabilities versus requirements did lead to two rather obvious conceptual choices. One choice is to select one of the special purpose systems conceived especially for the interim quick response task and to develop it as an addition to the current NRP photo-satellite mix. SPIN SCAN appears to be the best choice if this course is chosen. In this case, the costs of the new system are entirely additive and the system would be obsoleted with the introduction of a near-real-time system. The other choice is to develop an interim system which also satisfies the near-real-time requirements. The most promising concept which falls into this category is the Film Readout GAMBIT

(FROG). It has the advantage of being based on an existing system which allows us to forecast both costs and performance with a high degree of confidence. It has sufficient excess performance to permit a reduction in the number of GAMBIT and HEXAGON missions required and yet, being a GAMBIT variant, it increases the overall GAMBIT production base. This provides off-setting costs after IOC which make the FROG concept attractive on a long term basis. In the near term, however, it is one of the more expensive interim concepts evaluated.

Viewed as a near-real-time system, FROG provides essentially the same performance as EOI and provides it earlier at a significantly lower cost. However, the EOI appears to have several attractive features which no film-based system can match and is generally thought to be the imagery reconnaissance technique of the future. The EOI technology program has progressed well. System definition is underway with three contractors. The FY-1972 budget was prepared to cover a possible system development go-ahead decision around the end of CY-1971. Other options were felt to be less expensive and hence would easily be accommodated within FY-1972 budget totals.

The interim system issue is interwoven with the EOI issue in that we cannot, within our present budget, afford to initiate development of both systems unless other NRP program funding is significantly adjusted. The issue before ExCom then, is whether to initiate development of an interim system (probably SPIN SCAN) and proceed with system definition of EOI, leading to an early system go-ahead, or whether to keep EOI technology going at a reasonable level and initiate development of an "interim" system (probably FROG) which stands a good chance of fulfilling our requirements for the indefinite future. If the first option (SPIN SCAN) is taken, money for SPIN SCAN development can be provided within the existing budget by deferring initiation of EOI system development for about a year. If the second option (FROG) is taken, money for FROG development will delay system development of EOI for two years. After such a delay it might appear desirable to delay further until FROG results and their impact were evaluated. This would lead to an overall delay of three to four years. EOI technology would be continued at about the present rate.

Background:

At the January Special ExCom meeting, there was considerable discussion of interim systems. It was agreed that a hard look be taken at various approaches including "more of what we already have," GAMBIT and CORONA 6 PACKS, Film Readout GAMBIT and SPIN SCAN. As a result, CIA/OSP and SAFSP were asked to prepare developmental and programmatic data on the systems specifically mentioned at ExCom and on other appropriate concepts. The NRO field organizations in turn initiated contractor studies in some cases and in others undertook the effort in-house.

COMIREX completed its analysis of satellite imagery needs for an interim crisis response capability on 12 April and their current plans are to submit the resulting requirements statement to USIB on 22 April. During the process of this analysis, the NRO was shown the preliminary COMIREX results to provide a design basis for the alternative interim systems. Nominal interim requirements are summarized as follows:

a. Numbers of Critical Situations. System designers should plan for three to five critical situations each year, with perhaps two of these occurring simultaneously.

b. Access and Duration of Sustained Operations. The system should have the capability to sustain daily access to one or more widely separated crisis areas (and any associated warning and indications targets) for periods of approximately one month.

c. Targets Imaged and Capacity. On a daily basis, an interim system should be able to image up to 70 installation-sized targets (i.e., three by three NM). In addition, it should be able to perform area searches totaling 4,000 square nautical miles, and be able to search 300 nautical miles of lines of communication (assumed to be five nautical miles wide). Stereoscopic coverage is desired, but some monoscopic coverage would be acceptable.

d. Ground Resolved Distance (GRD). Imagery of installation-type targets should be at a GRD of two to three feet (one foot or less in infrequent special situations). Three to five feet generally would be required for the search of areas or lines of communication.

e. Tasking Through Imagery Viewing Times. It is desired that an interim system be able to access a crisis area within 12 hours of initial tasking and that within 12 hours of each imaging pass the data be available for initial viewing in Washington.

In the remainder of the paper all concepts considered are listed and described. A screening process reduces the number of concepts to the most promising. Finally, these latter concepts are addressed in terms of photo-satellite system mixes.

Description of Interim System Candidates:

The interim systems considered following the January 1971 ExCom meeting are listed and described below. Systems specifically mentioned at the meeting are marked with an asterisk. The others are variants of those mentioned or the result of additional proposals.

* Increased Number of HEXAGONS and GAMBITS

The concept of an increased number of existing systems envisions an improved posture for crisis response by providing for a photo reconnaissance satellite on orbit continuously. This approach provides an overall collection capability well in excess of standing requirements. No system modifications unique to the crisis response role would be accomplished. Six HEXAGONs and six GAMBITs annually with the current mission durations of thirty days and twenty days respectively would yield 300 photo-satellite days on orbit initially. An early increase in HEXAGON mission life to 45 days appears reasonable and present development will produce 27-day GAMBITs next year followed by up to 32-day missions by early 1974, comfortably exceeding a 360 days on-orbit goal.

* CORONA 6-PACK

The CORONA 6-PACK is based on an initial concept of the present AGENA vehicle and J-3 24-inch focal length camera system and six scaled down MARK VB reentry vehicles. A refurbished ATLAS booster would be used to accommodate the added payload weight and support a quick launch reaction time (8-12 hours). This system could be operational in 24 months but would not achieve the 3-5 foot resolution requirement. An improved 36-inch focal length camera meeting resolution requirements could be incorporated with only moderate structural changes and could be operational in 29 months. The plan shown envisions initial operation in 24 months from go-ahead with six systems using the J-3 camera followed by a phase-in of the improved camera 18 months later.

PINTO

The PINTO concept is an offshoot of the CORONA 6-PACK studies. The system would employ an AGENA vehicle utilizing portions of both the GAMBIT and CORONA configurations, a 48-inch focal length panoramic stereo camera adapted from the Fairchild K-81 aircraft camera design, and eight scaled down MARK V reentry vehicles. Like the CORONA 6-PACK, a refurbished ATLAS booster would be used, giving adequate payload capability and an 8-12 hour launch reaction time. Projected resolution for the PINTO camera is 24-45 inches (29 inch average) which meets the 3-5 foot requirement.

* GAMBIT 6-PACK

The GAMBIT 6-PACK concept is based on the use of the existing GAMBIT system modified to employ six smaller reentry vehicles of Lockheed design. Five of the RV's would be used to return film from the prime camera, the sixth being used for the Astro Position Terrain Camera film and tape recorder return. The additional payload weight with the GAMBIT Titan IIIB booster would result in an inclination penalty versus the standard GAMBIT (88 vs 110 degrees). There is the possibility that this could be off-set by minor booster modification. Six GAMBIT 6-PACKS annually are envisioned to satisfy standing surveillance requirements and provide added collection capability for crisis response.

GAMBIT 3-PACK

The GAMBIT 3-PACK was an offshoot of the GAMBIT 6-PACK effort and is a more straightforward, less complex and perhaps less expensive approach. The configuration would consist of the current GAMBIT system but with three rather than the present two MARK V reentry vehicles. The inclination penalty from increased payload weight as compared to the standard GAMBIT (93 vs 110 degrees) is less than that of the 6-PACK and the development of a smaller bucket would not be required. Like the 6-PACK, six missions per year would be required to satisfy standing requirements and provide added capability for crisis response. Fewer RV's would be available for more frequent data return, however (18 versus 30).

HEXAGON VARIANT

One HEXAGON concept was submitted and others are possible. The concept provided envisions the HEXAGON vehicle modified to replace one of four reentry vehicles with a module containing eight MARK V RV's and extending the mission lifetime to about 120 days. A possible mission profile would involve HEXAGON search/surveillance collection against standing requirements during about the first 30 days, using the three main RV's, followed by 90 days in a crisis response mode with eight smaller RV's available for rapid data return. Proper scheduling of four HEXAGONs/year could result in 120 days of normal collection and 360 days of potential crisis response. A variation would be to provide for transfer of film between main and crisis RV's on command. Other configurations such as replacement of the four current RV's with 16 MARK V RV's were considered but not costed.

AXUMITE

The AXUMITE concept is based on the development of a small, very quick reaction photo satellite system launched from an F-4 aircraft based in the Pacific. A typical mission would consist of launch within two hours of decision, one time coverage of the selected target area and Atlantic or Pacific reentry vehicle recovery. The booster would be based on the SKYBOLT solid rocket with Scout solid strap-ons. The camera would be a 32-inch focal length scaled up version of the CORONA camera yielding three-foot resolution at 75 nautical mile altitude. The reentry vehicle would be a scaled down version of the MARK V RV.

FASTBACK

The FASTBACK concept is based on the development of a relatively small, quick reaction photo-satellite system which would be launched on call from Johnson Island facilities in the Pacific. A mission would involve launch, one or two accesses to a target area depending on location and selected inclination, followed by Atlantic recovery. Hard photo copy in the Washington area within 24 hours from launch decision is claimed. FASTBACK would use a refurbished Minuteman I with an orbit inject motor on the spacecraft giving a fourth stage. The camera would be a 45-inch focal length rotating optical bar panoramic type, yielding about 2-foot resolution at nadir. The entire camera with film would be contained within the reentry vehicle and could be refurbished for reuse.

* SPIN SCAN

The preferred SPIN SCAN configuration weighs 1600 pounds and uses a dedicated Atlas E/F booster. Versions weighing 800 and 1200 pounds, amenable to HEXAGON piggyback launch, were also examined; but the resolution requirement dictated a 60-inch focal length, F/4.3 optical system which in turn requires the 1600-pound spacecraft.

As with previous versions of SPIN SCAN, the image is acquired on film, developed on board and scanned with a laser scanner to generate an analog video signal which is transmitted directly to a ground station for reconstruction into hard copy.

* FILM READOUT GAMBIT (FROG)

Film Readout GAMBIT is based on the existing GAMBIT spacecraft and booster, the 175-inch focal length R-5 lens and the minimum modifications necessary to provide longer life and a quick response readout capability. Readout is accomplished by laser scanning film which has been developed on board. The resulting analog video signal is transmitted directly to a ground station where it can be reconstructed into hard copy or retransmitted via communication satellite to Washington, D. C. for reconstruction of the hard copy.

Screening of Candidate Systems:

The purpose of this section is to describe the rationale which led to the selection of the most promising approaches. The selection process took into consideration cost, development time and performance against the interim crisis requirements. A number of supplementary factors were considered. These included surplus performance capability applicable to other requirements, the depth to which each approach had been studied, and the level of confidence in cost, schedule and performance estimates.

The interim system proposals were divided into the following categories to facilitate their evaluation:

a. Additional Existing Systems

b. Multiple Reentry Vehicle Variants of Existing Systems

c. Special Purpose Crisis Systems

d. Readout Version of Existing Systems

In order to avoid repetition, the most promising concepts will not be discussed in detail here since they are discussed in depth in the next section.

Additional Existing Systems

Any concept for achieving a crisis response capability from photo-satellites must be predicated on additional collection capability, timely availability of a suitable system on orbit and rapid, frequent imagery return. Additional existing systems, such as the six HEXAGONs/six GAMBITs mix described in the previous section, would provide enhanced collection capacity and on-orbit availability. At the time of any given crisis, available capability would be limited by the system then on orbit. HEXAGON and GAMBIT are not well suited to a crisis role, especially with regard to daily imagery return, nor are they amenable to quick launch reaction to supplement expended on-orbit capability. The decision to return reentry vehicles early to provide timely crisis imagery would always have to be weighed against the impact on standing requirements collection in terms of mission film wastage. The unit costs of GAMBIT and particularly HEXAGON are high versus the useful crisis capability gained. More detailed considerations as to performance, cost and crisis requirements satisfaction could be presented; however, it is evident that this approach is not a viable option.

Multi Reentry Vehicle
Variations of Existing Systems

This category of candidates includes 6-PACK and 3-PACK GAMBIT, HEXAGON variant, 6-PACK CORONA and PINTO. GAMBIT and HEXAGON candidates would represent modifications to on-going operational systems which would enhance crisis response. The CORONA and PINTO candidates would represent add on systems dedicated to crisis response.

The GAMBIT 6-PACK achieves some improvement over the current configuration with regard to crisis data return. A possible annual mix would consist of four 45-day HEXAGONs and six 27-day GAMBITs yielding near continuous satellite days on orbit. HEXAGON would expend 30 days each quarter (120 days/yr) on standing search/surveillance requirements leaving 15 days/quarter (60 days/year) available for crisis coverage. GAMBIT collection against standing surveillance requirements each quarter would require 20 days/quarter (80 days/year) leaving 82 days a year available for crisis coverage. The 142 days available for crises would appear rather favorable on the basis of 3-5 situations per year of up to 30 days duration each. When analyzed in terms of a given crisis occurrence, however, a different aspect emerges. A best case would be a crisis breakout at the start of a GAMBIT mission. The entire mission could be devoted to crisis coverage without impacting normal collection and all resolution requirements would be met. Daily imagery return, however, could only be effected for five days with considerable film wastage. GAMBIT is also somewhat limited in area coverage and in repetitive access capability. A worst case would involve a crisis breakout at the start of a HEXAGON mission. While the film on board could yield up to 15 days of crisis coverage without affecting normal collection, only four RV's would be available for film recovery. Daily imagery return could therefore be effected for only four days, and then only with severe impact on normal collection due to early mission termination and film wastage. HEXAGON would not meet the higher resolution requirements although its access capability is somewhat better than GAMBIT.

Similar considerations apply to a like option involving a GAMBIT 3-PACK with the exception that significantly fewer GAMBIT RV's would be available for rapid data return.

The 3 or 6-PACK modification to GAMBIT is considered to be well conceived and costed. The 3-PACK carries less cost and risk because no new RV development is required. It is interesting to note that the cost of providing 18 GAMBIT RV's per year using the 3-PACK would cost more than attaining the same end with nine of the present systems because unit costs are reduced as the production rate is increased.

The HEXAGON Variant initially appears attractive because of the larger number of crisis collection days available and the apparent low cost. Four missions/year would yield 360 potential crisis collection days on orbit, however, the currently planned reduction to three HEXAGONs/year in FY-1975 and subsequent years would require additional systems with attendant cost increases if this capability were to be maintained. Assuming a HEXAGON Variant on orbit at the time of crisis breakout, considerable time and area coverage would be possible. The 8 RV's, however, would permit only 8 daily imagery returns, following which the crisis capability would be expended. System failures would result in a loss of both normal and crisis collection capability since additional capability in the form of additional systems is not provided. The concept would introduce additional complexity into a film path whose development has had a history of difficulty. HEXAGON has yet to be proven on orbit in its present configuration.

From the foregoing discussion, it is evident that the HEXAGON and GAMBIT candidates might provide adequate crisis coverage for historical purposes, but would be quite limited in providing timely repetitive imagery return which could affect national decisions during a crisis period.

The CORONA 6-PACK and PINTO candidates offer considerable crisis performance advantages over the other options discussed in this section. Both would have an 8-12 hour quick launch reaction capability giving considerable flexibility with regard to optimum orbit selection and consideration of weather conditions in the target area. Since they are dedicated crisis systems, crisis collection and rapid imagery return would be accomplished without impact on the normal collection activities. A bonus effect would be their capability to provide backup to HEXAGON and GAMBIT in the event of system failures and/or special collection contingencies. PINTO would have the capability to provide daily imagery for eight days with the option of a follow-up launch on the eighth day to sustain this capability to 16 days. A more likely utilization would involve bucket return every other day. The CORONA 6-PACK would offer a similar option at a somewhat degraded level due to the fewer number of RV's. Both systems could operate for up to 30 days per launch with less frequent data return. Coverage and access aspects of the performance of both systems would be quite favorable. The PINTO camera and the new camera variant of the CORONA 6-PACK would meet all resolution requirements save the one foot requirement for precise identification. The PINTO and CORONA systems are based primarily on existing and proven components. As film return systems they can be regarded as totally conventional in their approach and completely amenable with past operational experience. It is clear that some development risks, however, are involved; the scaled down RV's, camera systems, AGENA vehicle modifications and system integration being cases in point. Performance characteristics would fall short of providing imagery for viewing within twelve hours of acquisition. Additive costs of these systems are relatively high, but are comparable to other candidates such as the 6-PACK GAMBIT. While neither 6-PACK CORONA nor PINTO were selected as preferred approaches, their combination of coverage and cost make them more attractive than the GAMBIT and HEXAGON candidates.

Special Purpose Crisis Systems

This category includes FASTBACK, AXUMITE and SPIN SCAN. The first two were eliminated from further consideration during the screening process. The rationale for that decision will be summarized here. Since SPIN SCAN was selected, a detailed discussion of it is in the section on selected concepts.

The FASTBACK concept has a number of desirable features. Among them are its relatively low cost, rapid access to most target areas, low vulnerability and inherent ability to take advantage of weather breaks. However, it disadvantages are overriding. Much of the cost advantage comes from the use of surplus MINUTEMAN I boosters. These boosters have limited payload capability and it was necessary, in order to meet the resolution requirement while staying within the weight constraints, to assume a beryllium folding flat and primary mirror. Based on our lack of experience with beryllium mirrors to date, this has to be viewed as a moderately risky approach. Another disadvantage is FAST-BACK's one-day life. A thirty-day crisis scenario is not uncommon and in such cases, the FASTBACK concept runs into two problems in attempting to provide daily coverage. First, it gets expensive, and second, the launch crews would be hard pressed to sustain continuous operations. In the baseline case, the contractor states he could make four launches in four days and five launches in the first month by the use of 100% overtime. After that the launch crew could sustain a rate of approximately three launches per month.

The overriding disadvantage of FASTBACK is its dependence on Atlantic Ocean recovery zone. The combination of weather and dense air traffic make air snatch recovery in this area very difficult, if not infeasible, compared to the Pacific recovery zone. In addition, activation and operation/training of an Atlantic recovery squadron to support only FASTBACK would be expensive and inefficient.

The AXUMITE concept was not the subject of a funded study. It is similar in many respects to FASTBACK but has an even more stringent payload weight constraint in the F-4 launched version. Being a one-day system like FASTBACK, AXUMITE could not provide sustained daily coverage of a crisis area. Atlantic recovery is not practical for the same reasons. Further reason for eliminating AXUMITE from further consideration is that the concept has not been developed sufficiently to warrant confidence in the cost and performance estimates.

<u>Readout Version of Existing Systems</u>

The Film Readout GAMBIT (FROG) is the only concept considered under this category. It is discussed in the next section.

Selected Concepts:

The most promising interim system choices are described below with emphasis on how they fit into the overall NRO photo-satellite mix.

SPIN SCAN

Description: As was discussed previously, the best of the special purpose crisis response systems is the 1600-pound SPIN SCAN. The HEXAGON and GAMBIT plans would remain unchanged. The system is sized at four launches per year. With the 1 May 1971 go-ahead, the first launch would be in August 1973.

The 1 May go-ahead requires a directed sole source procurement. A competitive source selection could be completed in time for a 1 July go-ahead.

Costs: Fiscal year costs are as follows:

Fiscal Year	71	72	73	74	75	76	77	Total
Non-Recurring	7.3	51.8	23.0	.6	0	0	0	82.7
Recurring	.3	3.6	26.0	38.1	37.1	36.9	36.7	178.7
Total	7.6	55.4	49.0	38.7	37.1	36.9	36.7	261.4

The per vehicle launched cost is $9.7 million.

Performance: SPIN SCAN satellites launched in response to fast-breaking critical situations would meet most of the nominal interim crisis response requirement. Such a system would not produce the imagery quality of a FROG system, but each

SPIN SCAN would have the advantage, due to its panoramic camera, of being able to image and return monoscopic data on any portion (or all) of the area which it accesses. It would have the additional advantage of being launched in an orbit tailored for a specific crisis area. The estimated performance of a four-spacecraft per year program would be as follows:

a. Number of Critical Situations. The system was designed specifically to accommodate the projected requirement which anticipated three to five critical situations per year. It could perhaps accommodate even more situations, depending on the timing of the actual crises and the amount of imagery acquired on each. The probability is very high that it could achieve this goal.

b. Access and Duration of Sustained Operations. A single SPIN SCAN would be able to sustain the required daily access to a single crisis area for up to eight weeks (twice the required duration), but would have a marginal probability of obtaining the crisis-associated warning and indications imagery. Two spacecraft might be required on orbit simultaneously to satisfactorily handle the requirement of collecting against additional crisis areas. Such a situation could complicate launch operations, and might result in the waste of some system capacity, but would improve the probability of imaging the crisis-associated warning and indications targets.

c. Targets Imaged and Capacity. A single SPIN SCAN should be able to exceed the requirement for daily search of areas totaling 4000 square nautical miles (maximum). As would be the case with FROG, SPIN SCAN might have some difficulty in performing the required daily search of lines of communication totaling up to 300 nautical miles in length, but should be able, in the worst case, to provide complete coverage every two days. A SPIN SCAN would have little difficulty in imaging, on a daily basis, the majority of the designated installation-type targets (70 or fewer) which are near or within a crisis area.

d. Ground Resolved Distance (GRD). Under the circumstances outlined above, a SPIN SCAN would meet the required GRD's of two to three feet for the surveillance of installations, and three to five feet for search of areas and lines of communication. Since the best nadir GRD of the proposed system lies between 2.5 and 2.8 feet, however, the occasional need for GRD's of one foot or less cannot be satisfied.

e. Tasking Through Imagery Viewing Times. The preferred version of SPIN SCAN would be orbited on demand with a dedicated booster. The launch reaction time would be 8 to 12 hours. Several more hours might be required to initially access the designated crisis area during daylight. Thus, the total time to first imaging might be of the order of 24 hours or so, about double the nominal required time of 12 hours or less. This longer time is equivalent, however, to the "minimum acceptable" time included in the requirement statement.

After daily access is achieved to the crisis area, the daily response times (imaging through viewing) should be nearly the same as those for FROG, a value somewhere within the range between 2.5 and 13.0 hours, depending on the location of the crisis area relative to the ground readout station near New Boston, N.H.

Discussion: Adding SPIN SCAN to the presently approved photo-satellite mix has the advantage of providing an interim crisis response capability in the second half of CY-1973. As discussed previously, SPIN SCAN meets the key interim system requirements.

The FY-1972 and 1973 costs, while considerable, are moderate compared to the other options. Thus, if interim system funds must come from existing and planned systems, the impact will be minimized.

It is desirable that the interim system be compatible with the ultimate near-real-time system. SPIN SCAN is somewhat compatible since it excels at repetitive coverage of a given area with good resolution by virtue of its ability to be launched into an earth synchronous orbit directly over the area of interest. It is complementary in another sense in that it would probably survive for several passes if the Soviets initiated attacks against our larger photo-satellites. Finally, it could serve as a back up to augment the near-real-time system and other photo-satellite systems. Four satellites per year would provide 224 days on orbit. As a back up it would provide near-real-time data, but not in the quality or quantity of the planned near-real-time system.

Whereas some of the interim systems considered since the last ExCom have been conceived only recently and have not been studied in depth by contractors, the SPIN SCAN concept has been studied in depth on two separate occasions with four aerospace and one optical system contractor participating. This results in high confidence in the cost, schedule and performance numbers.

The major disadvantage of this mix is that SPIN SCAN does not replace or reduce the quantity required of existing photo-satellite systems. Thus, all costs are additive to the existing base. In addition, even though moderate, the SPIN SCAN costs would require taking some of the funds presently budgeted for other efforts.

FROG

Description: This option results in a first launch 30 months from go-ahead. Costs are predicated on a launch rate of 2.8 per year which typically results in two systems on orbit. GAMBIT and possibly HEXAGON would phase down to two launches each per year following FROG IOC.

Costs: (Assuming 1 May go-ahead. By delaying until 1 August, FY-72 costs are reduced to $108 million.)

Fiscal Year	71	72	73	74	75	76	77	Total
Non-Recurring	7.5	100.5	52.6	4.5	0	0	0	165.1
Recurring	0	33.6	72.4	96.8	101.5	103.1	102.9	510.3
Total	7.5	134.1	125.0	101.3	101.5	103.1	102.9	675.4

The per vehicle launched cost is $36.7 million.

Performance: A system of two on-orbit FROGs would be able to meet a high percentage of the nominal interim crisis response requirements. Furthermore, such a system, particularly when not fully engaged in responding to fast-breaking situations, would be able to collect effectively against the world-wide warning and indications target set, a major task of the near-real-time requirements.

The estimated performance of a two-spacecraft system would be as follows:

a. Number of Critical Situations: The system would greatly exceed the requirement (three to five situations per year). It would have the capability to perform on a daily basis against several concurrent critical situations, being limited primarily by film capacity and readout rates.

b. Access and Duration of Sustained Operations. The system would be able to sustain the required daily access to one or more widely separated crisis areas for periods of any duration, not just the required one month. Normally the system should also be able to collect a satisfactory sample of crisis-associated warning and indications imagery. It might fall short in this category, however, if collection against multiple crisis areas required that both spacecraft be placed in daily repeating orbits.

c. Targets Imaged and Capacity. The system normally should be able to satisfy the requirement for daily search of areas totaling up to 4000 square nautical miles. Some difficulty might be encountered in accomplishing the required daily search of lines of communication totaling up to 300 nautical miles in length. How well the system performed in this category would be largely a function of the length and orientation of the lines of communications and their proximity to the area and installation targets. In the worst case, it should take no more than two days to provide complete coverage.

Most of the installation-type targets located near or within a crisis area could be accessed on the required daily basis, but it might not be possible to frame every selected target in cases where target concentrations cause tasking conflicts. Addition of the pitch agility capability would alleviate this problem. At worst, however, nearly all of the designated installation-type targets should be frameable every other day and the highest priority targets on a daily basis. In addition, stereoscopic coverage could be provided on selected targets.

d. Ground Resolved Distance (GRD). The potential collection capabilities listed above would be achieved at the required GRD's of two to three feet for the surveillance of installations, and three to five feet for search of areas and lines of communication. Under the special circumstances requiring a one-foot or less capability for the precise identification of equipment types, a FROG spacecraft could be maneuvered into an orbit with a lowered perigee, and then be returned to its normal orbit. Such an adjustment could be performed several times during the one-year spacecraft lifetime.

e. Tasking Through Imagery Viewing Times. Through its orbit-adjust capability, a FROG spacecraft should normally be able to access a crisis area and establish a one-day repeating access cycle within 24 hours from initial tasking. On the basis of a random crisis location and random spacecraft positions, the average minimum time between initial tasking and initial access for either spacecraft is near the required 12 hours (less if the spacecraft with most timely access were always selected). After daily access is achieved, the response times (imaging through initial viewing at Washington) should range between 2.5 and 13.0 hours depending on the location of the crisis area relative to the New Boston readout station. This time range would satisfy the normal required 12-hour response time. More rapid response times could be attained by adding a readout station and using a Defense Satellite Communications System II data link to Washington.

Discussion: The FROG development is well understood since it was studied extensively in 1965-66 and then studied again starting in November 1970. It is based on an existing spacecraft and optical system. As a result, the cost, schedule and performance of FROG can be predicted with high confidence.

FROG generally meets or exceeds the nominal stated interim system requirements, and in addition, it performs very well against the full near-real-time requirements. Accordingly, its development would not only provide an interim system but would also allow time for further refinement of the EOI design to the point where it would clearly be able to replace an existing system. We believe that to be cost-effective, future systems should supplant existing systems from the overall systems mix.

The FROG itself has the advantage of several growth modes. The basic FROG film readout approach technique could be part of a hybrid film return - film readout system which would provide VHR photography from low (90 NM) altitude and then orbit adjust to a higher altitude to operate as a near-real-time film readout system. The FROG concept also has a growth path where the film readout module is replaced with the tape storage camera.

In view of the obvious desirability of introducing new systems which supplant existing systems, the growth plan in which EOI would be designed to grow into a near-real-time area coverage/search system replacing HEXAGON and in which FROG would grow to a VHR capability replacing GAMBIT is a very attractive approach.

Since FROG has considerable excess capability above the interim system requirements, it can reduce the required GAMBIT launches to two per year.

Since FROG is a modified GAMBIT spacecraft, the deletion of two GAMBITs while adding three (2.8) FROGs per year results in a cost off-set. The two GAMBIT deletion avoids $50 million per year in FY-76 and FY-77 and somewhat less in earlier years. Thus, over the five-year period of FY-1973 through FY-1977, the cost off-set resulting from FROG is estimated to be $180 to $200 million against the estimated FY-1971 through FY-1977 cost of $675 million.

Based on its performance, FROG could also reduce HEXAGON launches to two per year with an apparent added potential for cost off-set. It is uncertain if such a course of action is desirable, however, since much of the cost avoidance would probably be lost in increased HEXAGON unit costs and the impact of an occasional HEXAGON system failure would be severe.

It should be noted that the FROG schedule quoted herein is 30 months to IOC. The pacing item is the optical system schedule which in turn is based on no manpower buildup at Eastman Kodak. SAFSP has estimated that the schedule could be shortened four to six months if Eastman Kodak were to add the necessary manpower.

The obvious disadvantage of this mix is the high cost in the near years, $108 million in FY-1972, $130 million in FY-1973 and $102 million in FY-1974 (assuming 1 August go-ahead). However, the savings resulting from reducing to two GAMBITs per year partially off-sets the FROG recurring costs resulting in a net annual recurring cost of about $40 million after FY-1974.