

Handout 9: The Gulf of Sidra Incident



Figure 1: Libyan President Colonel Muammar Abu Minyar al-QADHAFI, better known to the west as Gadaffi.

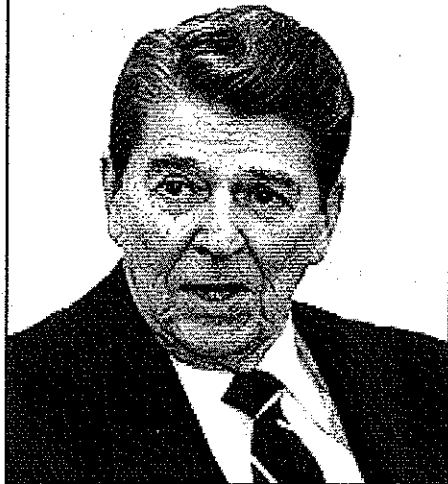


Figure 3: Former US President Ronald Reagan.

In 1981 Colonel Gadaffi (the President of Libya - see Figure 1¹) claimed the entire Gulf of Sidra as Libyan territorial waters (see Figure 2²).

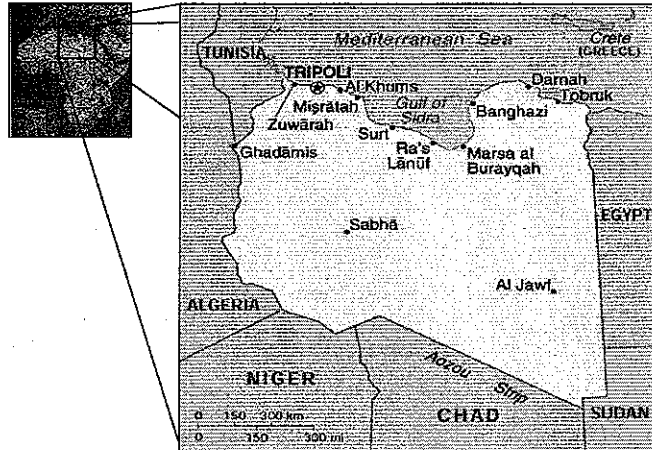


Figure 2: Location of the Northern African nation of Libya and the Gulf of Sidra.

This action was not in accord with international laws, and President Reagan (see Figure 3³) challenged this position by conducting naval exercises in the Gulf⁴.

The admiral commanding these naval forces ordered F-14's (see Figure 4⁵) to patrol at a distance of ten miles from the Libyan coast. Any unidentified aircraft crossing the Libyan coast at a speed of greater than 500 miles per hour was to be treated as hostile.

Figure 5 (see next page) shows one of the situations that developed during this crisis. An F-14 was circling (essentially remaining near the same spot) at an altitude of approximately 5.7 miles. When the F-14 was 10 miles (diagonal distance) from the coast, its AWG-9 air search radar detected an object moving rapidly across the Libyan coastline.

¹ Image source: <http://www.goal.com/es/esp/>

² Image sources: CIA World Factbook, 2002. and <http://www.africaguide.com/>

³ Image source: http://reagan.webteamone.com/reagan_images.cfm

⁴ Throughout these exercises, Libyan and US forces antagonized each other by approaching with every indication that they were preparing to attack. The most serious incident occurred on August 19, 1981, when a pair of Libyan Su-22 "Fitter" aircraft approached a pair of US Navy F-14's and fired an air-to-air missile. Both F-14's easily evaded the missile and returned fire destroying both Libyan aircraft.

⁵ Image source: US Navy, <http://www.navy.mil/>

SOLUTIONS

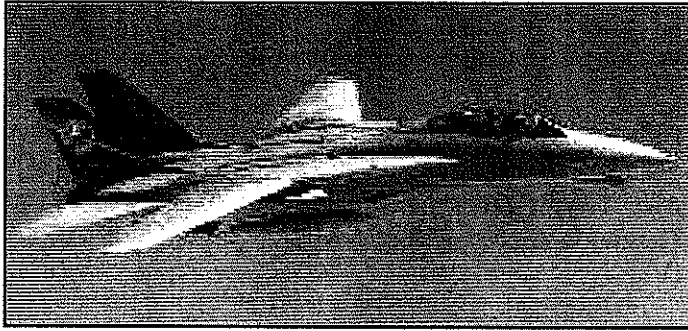


Figure 4: The F-14 Tomcat Fleet Defense Interceptor

The AWG-9 measures the rate at which the distance between the F-14 and the target changes. In this situation, the AWG-9 measured the rate of change of this distance to be 420 miles per hour.

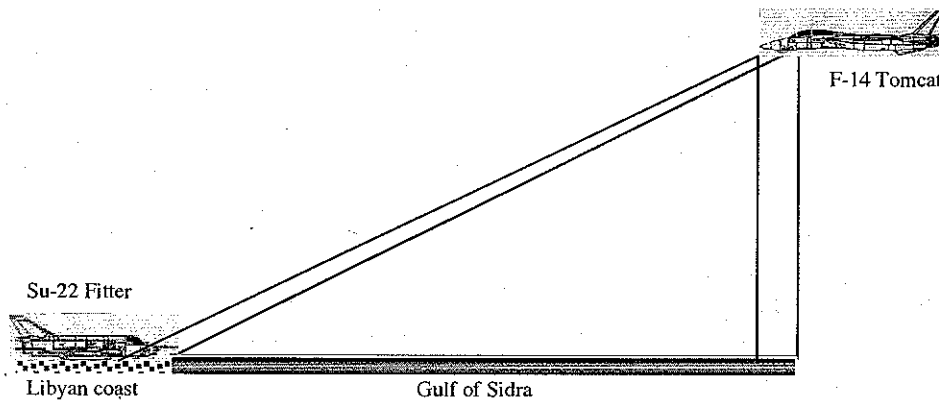


Figure 5: The situation at the start of the engagement.



Figure 6: A pair of Libyan Su-22 "Fitter" aircraft flying over a coastal region near the Gulf of Sidra.

In 1981, the Libyan airforce included a number of high performance Soviet made aircraft such as the Su-22 "Fitter" (see Figure 6⁶). The top speed⁷ of the Su-22 was approximately 1380 miles per hour.

⁶ Image source: <http://www.tbe.aims.on.ca/keele/emir/su-22.htm>

⁷ Source: <http://www.acrospaceweb.org/>

SOLUTIONS

In this handout, you will analyze the mathematics that the computer on the F-14 performed to convert the information from the AWG-9 radar into information about the speed of the object that the F-14 detected. When you have finished doing this, you will be able to decide whether the radar contact should be classified as "hostile" or not.

Let t represent the number of seconds that have elapsed since the F-14 first detected the target. Let $L(t)$ represent the diagonal distance (the length of the hypotenuse of the triangle in Figure 5) between the F-14 and the object. Let $R(t)$ represent the horizontal distance between the F-14 and the object (i.e. the length of the base of the triangle in Figure 5).

1. Using the quantities defined above to express your answer, what rate of change does the AWG-9 radar measure?

$$L'(t).$$

2. Using the quantities defined above to express your answer, what is the air speed of the object that the F-14 detected?

$$R'(t).$$

3. Using Figure 5, find a relationship between the functions $R(t)$ and $L(t)$. Use this relationship to find a relationship between the derivatives $R'(t)$ and $L'(t)$.

Let $H =$ altitude of F-14.

Theorem of Pythagoras:

$$H^2 + R(t)^2 = L(t)^2$$

Take derivatives:

$$2R(t) \cdot R'(t) = 2L(t) \cdot L'(t)$$

Solve for $R'(t)$:
$$R'(t) = \frac{L(t)}{R(t)} L'(t)$$

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4. This incident occurred when the diagonal distance between the F-14 and the Libyan coast was 10 miles. What was the horizontal distance between the F-14 and the object at the moment when the object crossed the Libyan coastline?

$$H = 5.7 \text{ miles} \quad L(t) = 10 \text{ miles.}$$

$$R(t) = \sqrt{10^2 - 5.7^2} \approx 8.216 \text{ miles.}$$

5. Use your answers to Questions 1-4, along with any other relevant information from the introduction, to calculate the air speed of the object as it crossed the Libyan coastline. In the actual incident, the F-14 crew classified the contact as hostile. Was their decision justified?

$$R'(t) = \frac{10}{8.216} (420) \approx 511.17 \text{ miles per hour.}$$

Yes the decision was justified.