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THE EFFECTS OF AERIAL WARFARE ON SPANISH UTILITIES
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I don't now whether I dare to address you all as 'Comrades'. If I did, you might take me to be a communist. But, anyhow, Friends, Instructors, and Students of The Army Industrial College

I don't know just where to begin this talk because there is so much to say and a comparatively short time in which to say it. It seems that I have gotten into trouble everywhere I have been, more or less.

I went to India in 1903 when I was a young man and was there for seven years. I had not been out there long before I became a member of a company of volunteers. We had to do considerable drilling and rifle practice and be prepared to protect ourselves and the company's property in case of riots among the Hindus and Mohammedans. I had had two years of cadet military training at the University of Illinois, so I was made lieutenant (pronounced 'lefttenant' by the British) of the company of volunteers, with a commission as such from Lord Minto, then Viceroy of India. Our engineering construction and operation progressed very well, however, in spite of some strikes and other labor troubles. Things went along very well. They are still having troubles in India, and Mahatma Gandhi, unfortunately, is again on a hunger strike to the death if necessary to defeat his political foes.

After seven years in India, I came home and spent a year in this country resting and taking post-graduate work at the University of Illinois. Then I went down to Old Mexico as Chief Electrical Engineer of the Rio Conchos Project near Santa Rosalia, and a revolution started down there just about that time. I found conditions far worse there than in India, especially during Pancho Villa's activities. I had the pleasure of meeting up with him a couple of times. The first time it was not so bad. He came into our camp as he was raising a big army to go down to Mexico City. President Madero had been assassinated and Huerta had been put in his place, so he was going down there to put Huerta out. When he came into our camp this time he treated us very well, saying he had come to protect us, and we need not have any fear, but he requested us to supply him with provisions and other things free of charge. During the night some of his 'soldiers' so-called, most of them bandits, stole six or eight of our horses from the corral, and when we reported it to him the next morning, he found out whom the guilty culprits were and had them taken out and shot and returned our horses to us. That was his way of dealing out justice.

The next time we encountered him, he had come down to kill off all the 'gringos'. The United States had recognized General Carranza as President, and Pancho Villa didn't like it. He expressed his dislike by trying to kill Americans. Before he arrived, we had to get out of camp on a special train sent to Parral and to Santa Rosalia to pick up our engineers and their families. We were armed with all sorts of weapons, pistols, shot guns, and rifles. We finally got out, although we really expected that the train would be ambushed, but fortunately it was not.

We had a very difficult time getting that hydro-electric project near Santa Rosalia completed. At that time (1913) the project was being

constructed by the Mexico Northern Power Company, a Canadian Company, but I believe this property is now under the control of the Electric Bond and Share Company. We had floods, strikes, revolution, and almost everything that could happen to prevent its completion. Two battles were fought right there in the camp, and several of us came near being killed. In fact, during one battle the engineers had to organize a Red Cross service to collect the wounded from the field of battle and take them to our camp hospital and look after them. (I shall have to make this part short because we have to get to Spain). Finally after four years of very difficult times, we managed to complete the project and put into service the plant, sub-stations, and fifty miles of double circuit 110 k.v. transmission line over to Parral for supplying power to a large number of mines in that district, this plant also later supplied power to the mines to the west of Chihuahua City. I had narrow escapes from Mexico three times during the revolution, and after getting out the last time, I decided it wasn't a very good country in which to live until conditions became more stabilized. I thought I would try to find a job where I could settle down for a while.

Early in 1917 I was offered a job in Spain with the Ebro Irrigation and Power Company. This is a large utility company which supplies light and power to more than four hundred towns and cities, covering the entire province or state of Catalonia, an area of about 15,000 square miles. There are about twenty hydro-electric plants, varying in size from the smallest to the largest which has a peak load capacity of about 75,000 k.w. That is the Camarasa plant located about 30 miles north of Lerida or about half way between Tromp and Lerida. There are a series of hydro plants beginning up in the Pyrenees. The highest head plant is Capdella under a head of 2,350 feet, a 30,000 kilowatt plant. That plant and others that are located lower down on the same river, (the Flamisell), the Noguera Pallerosa, Segre, and Ebro Rivers get their storage from about fifteen or twenty lakes up in the Pyrenees Mountains. The highest lake is at an altitude exceeding 8,000 feet, and the lowest level lake is about 6,000 feet. As I say, these lakes supply storage water for all the numerous power plants along the above-mentioned rivers, but in addition there are other large storage reservoirs created by concrete dams, the largest, located at Camarasa, is over 300 feet high, giving a storage of about 200,000,000 cubic meters. As all measurements in Europe (except the British Isles) are based on the metric system, I became more accustomed to the metric than to the English system of units. You can multiply 200,000,000 by 35 to get the cubic feet, which would be 7,000,000,000, that is a very large storage reservoir. As previously stated, this water is backed up by a gravity section concrete dam which is a little over 300 feet in height. At the time it was built, it was the highest dam in the world.

Then we have another large storage reservoir at Tromp. That name is probably familiar to you if you have kept in touch with the war news in Spain. It is where much of the fighting has been going on, all kinds of warfare, aerial and land bombardments, and infantry attacks. It is the point where General Franco began his final drive towards Barcelona last December. The concrete dam at Tromp is about 280 feet high, and the storage capacity of that reservoir is about the same as that at Camarasa. The large amount of storage in the numerous lakes in the Pyrenees Mountains, as well as that obtained by artificial storage reservoirs, provided a wonderful layout for the development of hydro-electric projects,

having an annual production of 880 millions of kilowatt-hours. Regardless of that, we had some stand-by steam plants which were mostly used in extremely dry years of water shortage. There are three steam plants in Barcelona with an aggregate capacity of about 80,000 h.p. Then we have another small steam plant located at a lignite mine about fifty miles northwest of Barcelona. This plant was subjected to aerial bombing several times, but not much damage was done because it was located in a place difficult of access. Bombing planes flew over the place at a great height failing to make any direct hits. Some damage, however, was done to outside equipment.

In Barcelona the Insurgents had more success in bombing one of our steam plants located on the outskirts of Barcelona where direct hits put the steam boiler equipment out of commission. On another occasion they damaged the sea water jetty, supporting structure for a long pipeline running out into the sea for the supply of condensing water for the boilers.

Later on the "Loyalists" installed new boiler equipment, repaired the condensing equipment, and were able to put the plant in service again long before Franco's forces captured Barcelona. The "Loyalists" were so desperate for fuel that they even cut down trees and used wood for fuel. Wood is very scarce in Spain so you can imagine they must have destroyed many valuable trees to provide fuel for this plant.

I assume that most of you know who the 'Loyalists' are, that is, what they represent. The fact is that they are a mixture of Radical Socialists, a few Left Republicans, Communists, and Anarchists, but they are 90 per cent a Communist organization.

I was in Barcelona for two months after the war broke out on July 18, 1936. In all my life I have never seen such a condition of anarchy and chaos as existed there. The Ford Company and General Motors had large assembly plants in Barcelona and maintained a very large stock of cars. The "Loyalists", so-called, simply confiscated all of those properties, and they confiscated all of our company's properties valued at over a hundred million dollars as well as all private property, homes, banks, hotels, stores, everything. That is the basic theory of the Communist form of government, that all private property should be taken over by "the state". So all private property was confiscated. I had an automobile for which I had a document from the President of the State of Catalonia, stating that my car was not to be taken because I had to have it for light and power service. But some armed "Red" militia-men came to my house and demanded the car. This was just a few days after the revolution broke out. When I showed them this document signed by their own President, they said, "Esta papel no tiene valor" (meaning this document is of no value), and then threw it on the ground and took my car. That is a sample of what the "Loyalists" were doing in those days, and they kept right on doing it for the duration of the war.

The "Loyalists" assassinated thousands upon thousands of innocent people in Barcelona who really did not want to have anything to do with the movement on either side. While I was there, I saw many people taken out of their homes, brutally mistreated, and shot in the residential district where I lived. They were taken to a private park not more than two hundred yards away in which were several private homes. The "Loyalists" -- I prefer to call them Communists or "Reds" -- took over this park, and they

made their headquarters in the largest of the private homes. It was a very palatial home, looking more like a castle than a home, and they hoisted a large red flag, not the flag of the republic, from the tower of this building. Every night of the two months I was there before leaving Barcelona, many home owners were taken to this park and shot, every night anywhere from twenty to one hundred people. I could hear the shooting between twelve midnight and two o'clock in the morning. You can imagine how much sleep I had in those days. It was a terrible situation in Barcelona and just as terrible in Madrid and other places controlled by the so-called "Loyalists".

People were being shot down on the streets. The armed Red militia men were racing around the streets in hundreds of stolen automobiles with their rifles sticking out the side windows and rear windows of the cars. They were just "itching" to shoot "Capitalists", anyone who did not give the Communist salute (left arm raised with clenched fist) was shot down. They would give the signal, three sharp blasts on the automobile horn, for people to salute, and those who didn't salute were shot. That was all there was to it. I came near being shot myself, but there is so much to tell that I must get on. I saw a young lad just around the corner from where I lived shot down in the street because he failed to give the Communist salute. The poor boy was probably trying to get out of the way of the rapidly moving car. They gave the signal blast for him to salute, and he didn't do it so was shot down. I wasn't shot, probably because they may have decided I was a "foreigner" and that I belonged to either the American or British consular service. That was the morning that I was walking down the street when this car filled with Reds came along behind and gave me the signal to salute. I was carrying my hat in one hand and my letter case in the other hand. In those days it was very risky to wear a hat. Anyone who wore a hat was taken to represent the property owning class, the bourgeois class, and was very apt to be shot. In fact, many of them were shot because they wore hats. They didn't even dare to wear a good suit of clothes. One had to put on the oldest suit of clothes for complete protection. That was the condition in Barcelona and all over that part of Spain controlled by the so-called "Loyalists" at the outset of the Spanish war.

The "Loyalists", who many people in our country believe are trying to maintain a republican or democratic form of government in Spain, are not and never have been. In fact, even the republican form of government in Spain set up on April 14, 1931 was bound to fail because of the great amount of illiteracy there. More than 65 per cent of the people, the peasant class, cannot read or write, and most of them have no idea what a republican or democratic form of government means.

I want to make it clear that I am heart and soul for the democratic form of government. I have to be able to protect ourselves, this country, against the encroachment of Communism, Fascism, or Nazism, or any other form of "ism" that is trying subversively to overthrow our democratic form of government. I want to emphasize the fact that the "Loyalists", which a great majority of the people in this country seem to favor, were not trying to maintain a republican or democratic form of government. They were trying to overthrow it, and if the "Loyalists" had won in Spain, they would have established, under the influence of Russia, a Soviet regime in Spain. General Franco has now practically won the war, and while he is not a perfect individual, he is a man of character and ability. I believe that he is really sincere in his desire to help all classes among his people, and that

under his leadership, Spain will again become a powerful nation. At the end of the war he will have at least a million well-trained, well-equipped men for his army. He will have a highly mechanized army with the very best equipment. There is no doubt in my mind that Spain is going to be a powerful nation, one to be reckoned with in the future. In fact, England and France now realize this, and that is why these two countries, not that they see a Franco victory, have been in a hurry to recognize his government and secure his friendship.

To get back to the subject of this talk, which I believe was to be more specifically about the effect of aerial bombardments of public utility services, I just couldn't help giving this preliminary view of the situation before getting down to the more specific subject in hand. As I said a while ago, the "Loyalists" confiscated all of our power plants, hydroelectric, steam, and gas plants. They were able to hold them all for a long time, in fact, until last April, when General Franco made an attack on Tramp and managed to drive the "Loyalists" back across the Noguera Palaresa River and took possession of the eight power plants in that region. When Franco restored our plants to us, I was called back to Spain. That is his plan, to restore all confiscated properties to their rightful owners. He did that with regard to the rich Rio Tinto copper mines down in southwestern Spain soon after the beginning of the war. You will perhaps remember that the "Loyalists" captured these copper mines from the British owners and tried to operate them. A few weeks later Franco came along and recaptured them, restoring them to their rightful owners, and the British engineers were requested to return and operate the properties. Franco has now returned all of our company's property, and I shall probably have to return to Spain in the very near future to continue the work of rehabilitation over there. I was called over there last May after he had liberated the first series of plants up near the Pyrenees Mountains, and we had to get these plants into running condition to supply power to the war industries in Franco (Nationalist) territory.

The largest industrial centers in Spain are the Barcelona and Bilbao districts, Barcelona on the Mediterranean and Bilbao on the northern coast. We had orders, therefore, to prepare these plants for power supply to the northern Franco territory. That was a big job because one of our plants, the one at Capdella that I have already told you about, had been damaged by bombing and by the greatest flood that anyone there could remember, the flood in the Flamisell River. This flood was caused by a very heavy snowfall in the Pyrenees in late October, 1937, which was followed by very heavy rains quickly melting the snow. There being no forests up in those rocky peaks of the Pyrenees, the water just came down like a deluge. The lakes at that time were all full so there was no hold-back for the water. It all came swooping down over the dams up at the lake. Fortunately no dams were destroyed, but huge boulders, some of them weighing from one to three tons or more, and trees at the lower levels, were visned with great force against the power house which was directly in the path of the flood. Sand, boulders, and other debris came through the windows of the turbine and generator room and piled up in great quantities over the turbines, generators, and other machinery as high as the switchboard gallery fifteen feet above the floor level. It was all a terrible mess to clean up and get the machines repaired and ready for service again, but it had to be done as quickly as possible. The War Industries in Spain were maintained as a separate organization

in the charge of the Minister of Industries, who was directly responsible to the head of the Nationalist Government, General Franco. In the beginning there was some conflict between the Military and the War Industries Departments, although both were directly responsible to General Franco. Those of us who had to deal with both sides found that we had considerable trouble at times due to conflicting orders. Some of us went up to Bilbao to discuss matters with the Minister of Industries in relation to the supply of power to the Bilbao district on the northern coast of Spain. Fortunately he was a man that we happened to know. We told him that it would take time for us to get these power plants, about six of them, ready for supplying power, that we had to clean up the Capdella plant and effect many necessary repairs. The Tresp 30,000 k.w. plant had also been bombed and badly damaged, and we had to build an interconnecting high tension line of about twenty-five miles to connect the transmission lines of two other utility companies. In fact, in order to transmit power to Bilbao, a distance of about 250 miles from Tresp, we had to connect four different H.T. systems, the voltages of which varied from 110 k.v. up to 135 k.v. We had to cut the poles out of the forest as there were no poles available and string the cables over those to make a provisional line.

When these difficulties were discussed with the Minister of War Industries, he became very excited when we said we couldn't do all of this work in such a short time. He said, "Why, you ought to get it done in two or three days. All you have to do -- I will give you all the men you want, a thousand men or five thousand, just take them out there and take down that other line that comes down from the plant that was destroyed by the Reds. You can put the transmission cable and insulators on the shoulders of these thousands of men and let them walk across the country with it. Why, that will only take two or three days." The Loyalists destroyed a fine new 90,000 k.w. plant in the northern part of Spain, the Safortunada plant. They dynamited it before they were driven over the border into France. This plant was therefore not available for power supply, and that was the chief reason they were demanding this quick supply of power for the Bilbao industries in Northern Spain. The Minister of War Industries thought it could be done very quickly, but we finally convinced him that it would take longer than two or three days, possible we could do it inside of two or three weeks. He didn't like that very well but said to go ahead, and he would give us all the men we needed, but to get it done. That was real cooperation.

Our men worked almost day and night on that line and got it finished in about two weeks. Then we had to make interconnections of the different lines at various places. There were five units, and we got three ready for service by the first of September. The remaining power plants we also got ready and put into service. Some of the engineers said we couldn't do it, that it was impossible. In fact, one of our plants was located up in the Valle de Aran three hundred miles from Bilbao, so that the total length of transmission was three hundred miles. I believe that is almost as long as the transmission from Boulder Dam to Los Angeles. It made one of the longest transmission lines in the world and one of the craziest looking lines, I think, but anyhow it succeeded. Some of our engineers said, "The charging line of the current will be too high. It will take the whole plant capacity to charge that long length of line." Anyhow, we were able to charge the line, at "no load," with a machine capacity of about 15,000 k.v.a. We maintained continuous service except that we had three interruptions of short duration due to aerial bombing. We had one outdoor

station up above Tromp at a place called Pobra, where there was also a big concentration of Franco's troops, since that was a very strategic point, in view of the fact that we had many many transmission lines feeding into this station. Here the voltage was stepped-up for transmission to Bilbao. The Loyalists knew, perhaps even before we started the actual power supply to Bilbao, that we were going to do it, consequently there were plenty of air raids in the attempt to destroy this large outdoor sub-station covering probably an acre and a half of ground. It is one of the largest outdoor switching stations in Europe. They kept repeatedly trying to bomb this station, very nearly getting it several times.

It was chiefly due to the protection of Franco's anti-aircraft guns, which were of the most modern German type, that they were able to preserve this station from destruction. On three occasions the planes managed to escape the barrage of anti-aircraft shellfire, and bombs were dropped all around the sub-station, but there were no direct hits of the structure. We had protected the large transformers and oil switches with heavy barriers of sand bags. These sand bags were built up to a height of about 15 feet to give us much protection as possible to the high tension bushings on top of the transformers. The latter were very difficult to protect, but insofar as actual protection to the transformers themselves were concerned, that is, the vital part of the transformers, we found that this form of protection was very valuable indeed. In no case where we used this form of protection, did we have any serious damage done to the equipment. There was some damage to bushings and naturally to insulators on the structures, also slight damage was done to parts of the steel structure, which was of lattice work construction. When bombs exploded outside the structure, the shrapnel would be sprayed up through it at an angle of about 30 degrees. Naturally the steel uprights and struts were cut in places, but there was no collapsing of any part of the structure. The same thing applied to the transmission lines. The planes would fly directly over the lines as far as they could until they were driven away by anti-aircraft guns or until all their bombs had been dropped. In flying directly over and along the lines, they would try to make direct hits. I often marvel that they were not able to do so. They did, however, cut the transmission cables in many places. Bombs would fall along both sides of a line, and the exploding shrapnel would be sprayed up, usually at an angle of about thirty degrees, striking the cables and cutting them partially or entirely in two. Our line crews were ready for quick emergency repairs at all times, so there was never an "outage" of more than one hour at any time.

One of the main objectives of aerial bombing was the power plant at Tromp. It was bombed by the "Insurgents" (Nationalists) early in 1937 when this plant was still in the hands of the Loyalists. I might say here that both sides usually refrained from bombing utility properties so long as they felt that there was any chance for them to maintain control of those properties because, naturally, electric power was essential to both sides for keeping the essential war industries going. Therefore, neither side wanted to destroy completely these power plants, but they both wanted to get control of them and were using every strategic means to do so -- the Loyalists to keep control, and Franco to get control by infantry attacks and by bombing auxiliary equipment or crippling outside equipment rather than destroy the plants. I think it is for this reason that there was not more destruction done by aerial bombardments, but as it was enough damage was done. The Insurgents, in bombing the Tromp plant early in 1937, made a direct hit through the roof of the high tension

room where there were a large number of oil switches and in doing so set fire to the oil which spread all over the floor. There was probably more damage done by the fire resulting than by the bombardment. Before the war started, we had nearly completed a large steel outdoor structure, because we had decided that since Trepmp was such a large converging center of power lines, we should move all of the high tension equipment out of doors on account of the fire risk. This was one of our older plants, the construction of which was begun during the World War, and was not completed until 1917. Although it was a well-constructed brick building, it had become antiquated as a power house structure

I would emphasize the necessity of designing and constructing all large and important power plants and sub-stations, located in strategic places, of heavy or reinforced concrete. Our later power plants, built since 1918, are of heavy reinforced concrete construction. The large Camarasa Plant has over a hundred tons of steel reinforcement. The roof of this plant has not less than twelve inch thickness of reinforced concrete. The Camarasa plant was bombed repeatedly. It is located in a gorge or canyon with rocky walls rising for over a thousand feet on both sides. The Loyalists occupied the cliff just above the power plant, and it was very easy for them to throw bombs down on the power house roof. So you can imagine what would have happened to that plant had it not been properly constructed to resist such attacks. That plant resisted aerial bombardments and the throwing of incendiary and explosive bombs of all kinds. The dam was also under attack as well as auxiliary equipment such as the spillway gates and head gates of the power canal leading to the fore bay of the power plant. Many attempts were made to destroy this auxiliary equipment, but without success. Of course the dam was so solidly constructed of massive concrete that no appreciable damage was done to it.

Another plant located about ten miles down the river below Camarasa was also under severe bombardment by the Loyalists. This plant of very heavy reinforced concrete construction came through with very little damage. In this case, however, the outdoor station containing high tension transformers and oil switches was damaged considerably by machine gun fire at close range. It was a very strange situation. The Insurgents had control of the power house proper with soldiers inside the power house, while the Loyalists were located across the river at the other end of the dam at very close range in trenches and behind barricades. The battle raged back and forth for several weeks for possession of this power plant. But, as I say, in spite of all the attacks and although it is a battle-scarred plant, it still stands, and the turbo-generator units are intact. I understand that they are not seriously damaged.

I don't want to talk too long this morning. I would rather give you a chance to ask questions, if you care to do so, as I feel that there are certain questions in your minds you would like to ask.