

# CHILEAN MINERS RESCUE ORAL HISTORY PROJECT

## EDITED ORAL HISTORY TRANSCRIPT

J. MICHAEL DUNCAN  
INTERVIEWED BY REBECCA WRIGHT  
WASHINGTON, D.C. – AUGUST 3, 2011

WRIGHT: Today is August 3, 2011. This oral history is being conducted with Dr. Michael Duncan in Washington, D.C., for the NASA Headquarters History Office. Dr. Duncan served as the Deputy Chief Medical Officer in the Space Life Sciences Directorate at the NASA Johnson Space Center [Houston, Texas], and is currently working in the Office of International and Interagency Relations at NASA Headquarters. This interview is part of a series to capture knowledge about NASA's participation in the 2010 historic rescue of thirty-three Chilean miners. The interviewer is Rebecca Wright.

Thanks again so much for spending time with me this morning. I know this is a special day with this whole effort, and we can talk more about that later, but I'd like for you to begin, if you would, explaining how NASA first became involved, and then especially how you became involved.

DUNCAN: Thanks, Rebecca. It's good to be with you and good to talk about this. We first became aware of the Chilean miners like most people did, by hearing of the entrapment on the news, and we watched that with interest. Then when the miners were discovered alive, within the next day the Chilean Space Agency contacted the NASA Deputy Administrator, Lori [B.] Garver, by email, and they knew to do that because of meeting Deputy Administrator Garver at a U.N. [United Nations] meeting for the Committee on the Peaceful Uses of Outer Space.

From Deputy Administrator Garver's office, it went down two arms within the agency: the engineering arm and the medical arm. I was contacted at Johnson Space Center because Johnson Space Center is where the majority of medical concerns relating to the astronauts are handled. We subsequently then made contact with the Chilean Minister of Health, Dr. [Jaime] Mañalich. We called him by cell phone, and he was at the mine site. We had a brief conversation that morning. I believe that was around the—let me do the math here. They were trapped on August 5<sup>th</sup>, seventeen days of entrapment, so they were found on the 22<sup>nd</sup>, and it was by the 25<sup>th</sup> that we made our first contact by phone with the Minister of Health.

After speaking to him briefly and getting a quick understanding of what he was dealing with with the miners from a medical and a psychological standpoint, we got our team members at Johnson Space Center together, consisting of Dr. J.D. [James D.] Polk, who at that time was the Chief of the Space Medicine Division, and also Dr. Al [Albert W.] Holland, who is an operational psychologist with a lot of long duration space flight support history in working with our astronauts, both aboard [Russian Space Station] *Mir* and the International Space Station.

We also had some ladies from the Nutritional Group accompany us, because that was one of the early concerns that the Minister of Health had, is how to re-feed the miners. They were actually interested in whether NASA had any particular formula of feeding that we might use with our astronauts that might be beneficial for the miners.

That afternoon [August 25, 2010] we had a more extensive conversation with the Minister of Health, Dr. Polk, Dr. Holland, the Nutrition Group [Sara R. Zwart, Barbara L. Rice, and Holly A. Dlouhy], and Minister Mañalich, and he had several of his team with him as well, that included physicians and psychologists. That conversation probably went on for about an hour. Following the conversation, we felt that it was important for us to be able to travel there in

order to get the best idea of what's really happening in this dynamic operational milieu down there, so we proceeded to gain permission to make the trip down there. So that's how we got started.

WRIGHT: Can you provide some of the other details about that trip? It's almost a year now since your travel down there. Reading through information, it almost sounds simple: "We need to go to Chile," but I'm sure there had to be some issues. If you could share with us, from your understanding and your involvement, how NASA and the [U.S.] State Department and the Chilean Government worked together to get you down there to where you needed to be so that you could offer that insight.

DUNCAN: After talking with the Minister and then talking in our small group—we are operational physicians and psychologists, so having our boots on the ground is the way we know how to do business best, how best to understand what the issues are. It's very difficult to gain a sense of complete understanding if you're just doing it by telephone. Once we talked and decided amongst ourselves that in order for us to provide the best consultation possible that it would be good for us to travel, we then contacted Al [Albert] Condes in this [NASA] Office of International and Interagency Relations. Al was very instrumental in talking with the State Department, to Chris [Christopher J.] Harris at the State Department. For us on the team, once we made the request and we explained to Al why we thought it was important, the activities that were going on were almost transparent to us. Al did a great job in working with State Department here locally, as well as working with the [U. S.] Embassy and State Department post in Santiago [Chile], making the arrangements.

We had tremendous support from Mr. Juan Fernando Acuña [Arenas], who was the Executive Secretary of the Chilean Space Agency. He was very instrumental in helping facilitate this as well, working with our State Department personnel in Santiago.

WRIGHT: Were you given any special guidelines or instructions from NASA or the State Department on how best to approach the government and the officials down there on how best to give your advice? Any suggestions?

DUNCAN: There are always dos and don'ts, if you will. We were, as an agency and a government, very concerned about liability issues, for example. How we would give our advice, how the advice would be accepted, would that put us in a position of liability? I know that Al and the State Department and various agency legal officials, attorneys, worked with our Chilean counterparts in their liaison with other government agencies to try to work out some of those details. We were providing our information and our insight and our best effort, and the Chileans would take that information and utilize it and make their own decisions, and therefore the team was not doing direct patient care, for example, and therefore we didn't have that concern for liability from the standpoint of the Chilean Government.

WRIGHT: You mentioned that you had a brief phone call and then an hour-long conversation. What did you ascertain from those phone calls? Based on what you knew, how did you prepare to go on this trip because you had such limited information?

DUNCAN: We had limited information, a very short phone conversation in the grand scheme of things. From a medical and psychological standpoint, as I mentioned, the team members, Dr. Polk was an emergency-room specialist with expertise in critical-care transport, and Dr. Holland was a psychologist with an extensive background on long-duration space flight, so those individuals were key in having the basic knowledge and understanding of what we were heading into.

Once we decided who the team members were going to be, the preparation centered more about what resources we needed to take with us. Certainly computers, access to the Internet, having a communications link via satellite, so we had satellite phones, those kinds of things, because we didn't know what we were going to run into when we got to the mine site. What we felt was once we got there and we had a better understanding of what was going on, we would need to make contact back with support personnel that we have in our Space Medicine Division, for example, or in other areas, other academic centers that we work through all the time. It was very important to be able to communicate. Beyond that, just the logistics of physically getting there, and we relied a lot on the Chileans. We got to Santiago and then the Chileans got us everywhere else that we needed to be. So that was the prep.

I think it's also important to note that in parallel, we have the engineering group, and Mr. Clint [H.] Cragg, who was the fourth member of our team, was working with his technical fellows through the NASA Engineering and Safety Center. Dr. Polk and Dr. Holland and I actually sat in on some preliminary telecons [telephone conferences] that Clint had with his team members, [The first telecon, lead by Clint Cragg, was on August 24, 2010.] thinking about what is it, from an engineering standpoint, that NASA might be able to consult with them on. There was a variety of things in terms of communication with the miners, how do you communicate

with them underground, to eventually, as we all know, we got involved with looking at design requirements or design suggestions for what the Chileans eventually called the Phoenix [Fenix] capsule. Ultimately they did all the design work and all the construction of that capsule, but our engineering team member and his technical fellows were able to give them some things to think about [design considerations] along the way.

WRIGHT: I want to come back to that, because I know that from what he [Cragg] told us, they certainly listened to the medical community as well. Talk about your arrival in Santiago and then the progression of meeting originally with those officials and then your travels up to this remote area.

DUNCAN: We left Houston on the 30<sup>th</sup> of August and arrived in Santiago on August 31<sup>st</sup>. It's an overnight flight from Houston through Lima [Peru], and you get to Santiago early in the morning. Santiago at that time was equivalent to East Coast time [Eastern Standard Time, EST], versus Central [Standard] Time for Houston, so it wasn't a huge time difference.

The State Department met us at the airport, as did the Chilean officials, primarily Mr. Acuña from the Chilean Space Agency, and they shepherded us to an area where we could relax for a little bit while they helped with [Chilean] Customs and Immigration. From there, they took us directly to the hotel. As I said, it was pretty early in the morning, so they allowed us a couple of hours to maybe get a little rest and showered.

Then I think it was about ten o'clock that morning they took us over to the Minister of Mining's office and we met the Minister of Mining, whose name is [Laurence Nelson] Golborne [Riveros], met him, and met the Minister of Health there. They went through a very detailed

discussion of where they thought things were with the miners, both from a health standpoint, a psychological standpoint, and what they were doing from an engineering standpoint, both to tell us about what actually happened during the cave-in to cause the entrapment, where they were trapped, and what they were doing from a planning standpoint to get these holes drilled to supply them with food and water and electricity, as well as the rescue holes that they were planning to drill, and the three basic plans for drilling those rescue holes.

That was a very detailed briefing. We were able to understand that they were really focused on the actual rescue itself, support the miners now and work towards the rescue and get them to the surface as soon as they could. I think because it was so early on after they had just discovered these men alive, that they hadn't had time to think through yet what they were going to do when they did get them to the surface. How were they going to triage them? How were they going to transport them to the nearest medical facilities? What kind of transport to use? Those kinds of things, and also what they were going to need to do with the families both during the time that the men were trapped, and then once the men were back to the surface, how they would be reintegrated back into the family life, be reintegrated back into society. These were things that we were able to bring up early on just in those very early discussions with them, and I think they felt that there was going to be real value in having us help them think through those kinds of things.

After the briefing in the Minister's office, we went to a more formal conference room and had slide presentations and they played video for us of the miners. Of course, a lot of that the public saw as this whole event unfolded worldwide.

Following that, they wanted to do a quick press conference, so you can see in some of the pictures of us in that conference room, there was a huge collection of microphones. It reminded

me of seeing photos or newsreel footage of interviews going on with these huge microphones in place. Then across the room we were looking at probably fifty, sixty, maybe seventy reporters and camera operators. I found myself centrally behind all this big collection of microphones sitting there at the table, so most of the questions were directed to me, and I had the Ministers on my flank. It was quite an interesting introduction into what we were embarking on.

WRIGHT: Specifically thinking about those moments, how do you think NASA was being perceived in this country, coming in to assist in this effort?

DUNCAN: I think it was all very positive. As we came to know the Chileans in the few days that we were down there, we came to understand that the Chileans are a people that believe in science and technology. I think the other thing that was important to reinforce in our minds is just how well that NASA emblem, what we call the meatball, is recognized throughout the world and what it stands for. It stands for excellence in science and technology and that can-do spirit. I think it was very positive from the get-go. Of course, this was a situation that was unprecedented. Never before had so many men been trapped so deep, in those kinds of conditions, and certainly hopefully to be rescued alive in the coming weeks. So, yes, it was a very positive circumstance, and I think that continued throughout the time that we were there.

WRIGHT: You left that environment with all the microphones and the recorders and then ventured off to this very remote area where the mine was. Give me your impressions, as you traveled up to this place where these people were trapped underground and the surroundings and

then, of course, how you became part of that scene and that environment, because you were able to speak with them in a type of a conference as well.

DUNCAN: Let me also say one other thing about after the press conference. They did take us to the offices of Codelco [Corporación Nacional del Cobre de Chile (National Copper Corporation of Chile)], which is the government-run engineering, mining organization down there. The Codelco folks gave us a more detailed briefing about the mine itself and their plans. Then we eventually were taken to the Undersecretary of Economics [Tomás Flores Jaña], who also wears the hat of the head of their Chilean Space Agency, so we got to meet and visit with him.

The next morning, the Chileans got us up bright and early and we got on a flight from Santiago to Copiapó. That flight was about an hour long, and it was pretty much due north of Santiago. You're flying along, and out the window you're looking at this very arid landscape, yet off in the distance you can see mountains in one direction or ocean in the other direction.

When we got to Copiapó, the press was also there, and it was at that point that our State Department handlers really stepped in, because we weren't there to be doing a lot of press conferences. We knew that that had to be part of it, but primarily we were there to meet with our counterparts, understand what the miners' situation was, and get on with the business of consulting with our colleagues and providing them our insights.

From the airport we traveled by van to Copiapó, checked into our hotel there, had just a few minutes to unpack, and then proceeded on to the mine site, which it takes about forty-five minutes or so, as I recall, by van, to go from Copiapó to the mine site. That's a very winding road, initially paved, then becoming unpaved, very dusty out in the desert. Yet the desert region had had some rain in their early spring or over their winter. One lady who was with the Office of

Economics [Sophia Slovena Cid Versalovic] was very excited about her country, about the state, the region of Atacama, and she was pointing out the little yellow flowers and then there were some purple flowers, and it was all on the hillsides of this very arid desert. It really gave it that kind of painted look. So it had its own intrinsic beauty, even though it was very, very remote.

We continued to press on to the mine site, and as you got to the mine site, it became even more desolate and arid, and it had that Mars-like look to it. Of course, the Chileans have what they call the Moons-Mars Atacama Research Station now, where they hope to attract academia and other agencies to participate in doing research to try to understand how, as we explore the solar system or explore Mars in particular, we might understand where to look for life on that remote planet.

We get to the mine site and we go through several checkpoints of police. There's a lot of talking between the driver and the security guard, and of course it's in Spanish. Then all of a sudden you hear the word "NASA" in the conversation, and all of a sudden the gate opens and we were able to drive through.

As we got closer, the first thing you go through is the area where the press corps was, so there were a lot of photos being taken of the van, photos trying to look inside the van of who was coming. Eventually we got to our point of work, the little building where we were going to be working out of. We could see Camp Hope, which is where the families were living. They had a series of yellow and orange and white tents there for them to live. Then on the hillside at the mine site there were thirty-three flags, thirty-two of them Chilean and one of them Bolivian, each representing one of the miners that was trapped. So that's the scene.

As we got deeper into where the drilling was, it was very dusty, very, very fine dust, almost like a cement powder kind of consistency that got into everything. In the mornings it

would be quite cool and then it would heat up during the day. Then in the evenings it would rapidly cool off again and we'd actually have this fog rolling in over the hillsides and the mountaintops there.

That was our exposure to getting to the mine site, and once inside, there was just a beehive of activity, with graders moving dirt, bulldozers. The Plan A drill was in process up at the top of the hill. Each of the Paloma [capsule] sites, Palomas were the five-inch holes, and the Palomas themselves were the metal cylinders where they would put foodstuffs or whatever they wanted to transport down to the miners. Like I said, it was just a beehive of activity back in there.

WRIGHT: Although as a team you knew the details, what kind of impact did it have on you personally as you were driving up? You were met with this definite impression with the flags and the families. This was a very impending and a very urgent matter to take care of. Did you feel that as well as when you started the talks with the people that were on the ground? And then if you could move into giving us information about how those talks, once you were there and you began talking with the people that were on the site, gathered more information, and then how you began to exchange that information to come up with more suggestions for them.

DUNCAN: As we got to the mine site and you saw where the families were living or you saw the flags, it really reminded you that this was real, that there were lives at stake, there were families that needed to be tended to and cared for. It's hard to describe just how big this operation—when I say it was a beehive of activity, I mean it was obvious that the Chilean Government was making an all-out effort to do whatever it could to rescue these men.

Shortly after we arrived at the mine site, they did take us to one of the Paloma sites where they had established two-way communication, essentially a telephone, and they were getting ready to have a private medical conference with the one miner that had some bit of medical background. He was going to update the topside physicians on just exactly what conditions were like, the health conditions that he was seeing, any injuries, skin breakdown, whatever.

Our colleagues allowed us the opportunity to say hello to the miners. Dr. Polk and I were in this little cabin with the other physicians, and they handed me the telephone. I remembered enough high-school Spanish to say hello, “Hola, cómo está?” at which point the miner who had answered the call started talking back to me in Spanish, and of course I’m not really getting what he’s saying. They’re trying to tell me in my ear what he’s saying. Then all of a sudden I’m realizing that I need to respond in some way, and I couldn’t think of what to say in Spanish, so my colleagues just whispered in my ear, “Just say *bien*,” which is “good.” Because he was asking me how I was, basically.

Dr. Polk is just shaking his head, “Oh, my gosh, he can’t speak Spanish,” and he’s ribbing me for the rest of the day, and even the next morning, the guys are ribbing me a little bit about not being able to speak Spanish when I needed to. Then somebody brings in the morning newspaper, and of course it’s in Spanish. Somebody translates that for us, because there’s a picture that was taken the previous day and talked about the fact that the NASA team was there. In the body of the article it made this comment, “Dr. Duncan, NASA team leader, speaking in Spanish to the miners.” I really got a break from the press corps on that one. It was fun.

WRIGHT: And it’s a newspaper so it’s true. [laughs]

DUNCAN: Yes. So that gives you, I think, a sense of what it was to be at the mine site. As we got the tour of the mine site, then we began to sit down with our individual colleagues, medical representatives, psychologists, engineers. It was really quite interesting how well we immediately gelled into what I consider a team.

For example, the engineer, Clint Cragg, is retired from the Navy, a former submarine commander, and one of the Chileans who was involved with some oversight responsibilities at the mine site and helping to coordinate activities,[was also a] Chilean submarine commander,[in the] Chilean Navy. We had no idea when Clint was assigned to the team that that would be his counterpart. So immediately, submarine commanders, there aren't very many of those guys and certainly not in Chile, they just hit it off and had a great rapport.

The Chilean psychologist, his first name was Al [last name Iturra], as was our psychologist, Al Holland. So those two guys hit it off very well. J.D. Polk and I interfaced with a Chilean submarine medical officer [Dr. Andrés Llarena], and he had lived in the United States when he was growing up as his father was attending graduate school, so he had a great command of the English language, had a great sense of humor. It was just very interesting how our team personalities and backgrounds interfaced with their team personalities and backgrounds, and there wasn't pre-coordination. It just was very interesting to see how that unfolded.

WRIGHT: You were cast in the role of the team lead for NASA, the one who got to sit in front of all those microphones, and people began coming to you, looking for answers. Share with us how you were able to coordinate the activities of your team and/or with the Chileans. Talk about that level of responsibility, because you only had a very short amount of time to find out what you needed to find out so that you could help those miners.

DUNCAN: The beauty of being a team leader of this team was you had three other individuals on the team who were all self-motivated, self-starting, highly educated experts in their field. It wasn't a matter of I needed to tell each of them what to do and when to do it; it was a matter of letting it happen, really. We would communicate with one another and talk through things, but as it unfolded, my job became more of the team spokesperson, especially to the media, talking with the Minister of Health, those kinds of things.

As the day would unfold, Dr. Polk would talk to the medical counterpart, Dr. Holland would be working with the psychological counterpart, and Clint would be working with his engineering counterpart. At the end of the day, we would tend to come back together as a team. We would ask our Chilean counterparts to let us work together. They provided a small little room, and that's where we would talk through things as a team, and then I would give my thoughts as well. So that's how the thing unfolded. Sometimes leadership requires different responsibilities and efforts. In this particular activity, all the team members, as I said, were self-motivated experts [and leaders in their own right] and it really made the lead job quite easy from that standpoint.

As the day would continue on, the Chileans would always come to this central building where they provided us space, and at the end of the day they would go over the activities of the day, review progress that was made or, in some cases, review progress that hadn't been made and why, and what they were going to do about that, and go over kind of the plan for the next day. That was not only the engineering and drilling aspects, but the health aspects. That information was presented to the Intendencia [Ximena Matas Quilodrán], which is the local—I

don't know if it's a governor-type equivalent, but she was a fairly high-ranking official for this region, Atacama.

Once that briefing was over, then the Chileans would always go talk to the families and give them a status update on the events of the day and what was planned for the next day, and we were allowed to attend one of those family meetings. It was very interesting. When we were introduced to the families, one of the things that the Chileans do is they go through this chant which they kind of spell out "Chile," and it goes, "Chi-chi-chi-le-le-le," and they had modified it to say something like, "Mineros de Chile," which is "Miners of Chile." Normally this chant is for their football team or whatever else that they're trying to promote enthusiasm for, but it's also done as a sign of support and welcoming. So despite my poor Spanish when I was talking to the miner on the phone, he got all his buddies nearby and they did that chant for us, which was really heartwarming. When they introduced us then later in the day to the families, the families did the same thing.

We each got to address the families. Al Holland, I remember, made this very passionate speech or commentary to the families, how happy we were to be there and that we'd do our best to help so that eventually their loved ones would come home. This lady that was sort of the self-appointed mayor of Camp Hope got up and said, "I'll adopt him right now." We always gave Al a hard time about being adopted.

WRIGHT: Now he's got family.

DUNCAN: Now he has family.

WRIGHT: If you could, take a few minutes and share how as a team you were able to take the information that you had, even back from that very first telecon, because I understand you came up with a list of recommendations at that point and sent them prior to your arrival, but then how the information changed and how you then began to come up with those recommendations. You mentioned that on the first day that you guys met, talking about triaging, that possibly they had never thought about the end of what was going to happen once they got rescued. I know that there's lots of information that you guys absorbed. Tell us how you turned that back around, and how this would be a part of understanding how the lessons learned from long-duration space flight has helped with these miners.

DUNCAN: The initial discussions that we had on the phone before we left Houston primarily centered around the medical condition of the miners [and nutrition]. They described some specific medical conditions that they were dealing with. They also talked to us about their plans for re-feeding the miners, because you have to understand that for those seventeen days that the miners were trapped, that they were primarily starving. They were only getting maybe a teaspoonful of tuna every other day, maybe a sliced peach from canned peaches that they had, and they really weren't getting enough calories to sustain them for very long.

As we know from other events in history, re-feeding prisoners of war, for example, if you don't do it properly, you can overfeed them early on, and those individuals can even die from metabolic disturbances related to the re-feeding. So it was very important for us to understand how they were re-feeding the miners and what their plans were.

Actually, they had done a good job of thinking through the re-feeding. We were initially a little concerned that they were going to be giving them too much glucose substrate,

carbohydrate substrate, but they were confounded simply by access. They couldn't get a big volume of stuff through those Palomas down to the miners themselves, so that helped out in avoiding the issue of overfeeding too early. But we did talk to them about the re-feeding syndrome. As I recall, we sent them some information about kinds of re-feeding. Nutritional supplements that we would use in this country, they were using something similar that they had access to. We talked to them about the buildup of the caloric intake and what the content of this should be in terms of protein and carbohydrate, fat, calories, minerals, vitamins.

As we got down there and learned more about the specific medical conditions that they were dealing with, now we're just talking as doctors, whether it's space flight or not. We did interject our thoughts about things like stress and the development of what we call latent virus reactivation. One of the things we've seen in our astronauts is development of fever blisters. Herpes virus is a latent virus, and so [under stress] the immune system is modulated in a certain fashion so that you get reactivation of those kinds of viruses. We thought maybe we ought to bring that up, this kind of isolated environment, stressful environment, their miners might be having that kind of a condition, and they needed to be prepared to treat that if necessary.

The other thing that was similar to space flight is with our astronauts being inside the Space Station or the Space Shuttle, you don't get a lot of direct sunlight, so for long periods of time on the Space Station without direct sunlight, you start to have Vitamin D deficiencies. Same thing would apply to the miners. We talked to them about how we replace Vitamin D and the importance of that. So those are just a couple of examples about how space flight helped the medical.

In my opinion, I think the biggest help we provided them was really from the psychological aspect. In preparing for long-duration space flight, we put our astronauts and their

families through some training programs and they understand what's about to unfold, and talk to them about some dynamics that can develop. If you're armed with that kind of knowledge, then maybe those dynamics won't develop, or not to the extent of difficulties that could otherwise develop.

The miners, obviously, weren't prepared to be entrapped, and the families weren't prepared. Everybody understands that it's risky business, for sure, but there's no educational process that they go through. Al's job was to help that educational process, both of the miners themselves and of the families, and talk to his counterpart about some things to think about, ways to communicate with the miners, ways to communicate with the families, helping the families understand, helping the miners understand not only what they're going through, but what their families are going through, and vice versa. One of the things that you don't want to see happen is for the families to start burdening the miner with additional problems on the home front, the pipes are leaking or the roof leaks, or those kinds of things. So just educating the two groups on how to communicate and the priorities of those communications.

The miners themselves did a great job in organizing themselves even before they were rescued. For those seventeen days, the shift foreman managed to maintain leadership. He established three shifts, workers' leads for each of those shift. He established a lead for medical issues, not unlike our crew medical officer that we train for space flight. Not every [space] crew has a physician with them. So they [the miners] had established a crew medical officer, if you will. They'd also established somebody that was an older gentleman that could maybe tend to their spiritual needs.

The miners really showed that will to survive, will to stay organized and coordinated and work through their problems. That's not to say that they didn't have maybe disagreements or a

small group break off and try to do their own thing, but eventually when it was obvious that there was no way out, everybody came back together. The psychological support, educating them, establishing work-rest cycles, shift work, establishing responsibilities, having true work to be done, not just busywork, all these things were very important for Al to talk through with his counterpart.

Then you've got to understand that we come from one culture, they come from a different culture, so as the consultation or the dialogue continues, it's not something that you write down and say, "You must do this." It's something that you talk through. You try to understand their perspective and just offer insight, and ultimately it's their decision to make on what to do next. But we found that our counterparts were very receptive and listening. They listened to everything and, from what we understand, implemented a good portion of the things that we had commented on and suggested. But that's how things unfolded.

WRIGHT: The engineering group that Clint led, they discussed quite a number of recommendations and insights together in a very short amount of time. But from what he shared was that they wanted to incorporate much of the medical input. Can you share how those two totally different cultures in themselves, engineering and medical, came together to provide a paper that had both technical and attributes for physical conditions as well?

DUNCAN: You've got to remember that at NASA we're really good about writing requirements for spacecraft, especially when it comes to human space flight. We have a lot of history of the medical side of the house and the engineering side of the house working together on spacecraft from an environment standpoint, from human-factors standpoint.

Especially with regards to the design of the Phoenix [Fenix] capsule, Clint understood at the beginning that the Chileans had minimal design requirements. Basically they knew that the capsule could only be so many inches in diameter, because they could only drill so big a hole. It could only be so long, because they weren't sure about how true, in terms of a straight line, the hole they were boring was as it went down to that 2200-, 2300-foot level. If you made it too long, there was the risk that it would get stuck in a bow, so obviously you didn't want that to happen. Then ultimately there would be a weight limit, but that weight limit was 15,000 pounds, so it wasn't going to really affect what needed to be done. That was our understanding what the naval engineers from Chile were working with in terms of the basic design for the rescue capsule.

Interestingly, all the mining that goes on in the world and all the entrapments that have occurred, there is no commercially available rescue capsule that you can just go buy off the shelf and bore a hole and go down and rescue anybody that's trapped. They were really designing something from scratch. I made a statement in a press conference once that the Chileans were really writing the book on how to do this kind of rescue, and this capsule design was part of that.

What Clint and his team thought about were things like how do you keep this thing from getting stuck? How do you cushion the ride? What other things should you be thinking about in terms of safety factors and strength of the materials? What do you do if it does get stuck? How do you get that guy out of there? If it's stuck, he's not going up. How do you get him back down to at least where he started from? So they went through a series of design suggestions.

From a medical standpoint and a psychologic standpoint, we felt it was very important for the miner to be able to communicate topside during the transit of the rescue capsule from the 2200-foot level up to the surface. How do you go about providing two-way audio, providing

video capability? That capsule was going to be fairly confined. There's not going to be a lot of air movement. So how do you provide some supplemental oxygen for the miner to breathe, to prevent suffocation?

We were also concerned about the fact that when we were initially down there, we had various times told to us in terms of how long the Chileans felt the transit time was going to take, and that ranged from a couple of hours to four hours. This was going to be pretty much a vertical ascent. They wanted to understand how fast they could ascend. If, indeed, it was going to last four hours, the individual would be virtually standing for four hours, and anybody who's stood at attention in military inspections on a hot day knows that there's a high likelihood of fainting. We certainly didn't want that to happen.

This brings back around the idea of what we do for our astronauts returning from space flight, because for a different reason they are susceptible to fainting as well. We had certain engineering solutions to ward against fainting by using compression stockings on the lower extremities, for example, having a small seat for them to just take some of the weight off from their legs, having the miner do what we term as fluid loading before they got into the capsule to ascend. Again, they were in a hot, humid environment. They may be dehydrated, so we wanted to make sure that they had adequate hydration, all in an effort to keep their blood pressure up.

These are things that the medical and the engineering side of the house within NASA are very comfortable in talking about, and so a lot of Clint's technical fellows had a lot of experience in working with the medical side of the house, and so that's how that was blended together.

WRIGHT: Your paper, collectively, was sent—I believe it had a date on it of September 10th, and so that part of your effort was completed, but your cooperation and your communication didn't

stop at that time, or did it? How much more involvement did you have past when you submitted your recommendations or suggestions for them to look at?

DUNCAN: We left Copiapó on the 4th of September and flew back from Santiago back to Houston, and so I think you're right about the date on that report. The next five days back in Houston and also at [NASA] Langley Research Center in Hampton, Virginia, those five days were pretty intense in terms of writing down the recommendations and getting the engineers that Clint was working with, getting all their requirements or suggested requirements into this paper was a very intense effort, and then that was transmitted to our counterparts by email.

WRIGHT: Did you see that before it went?

DUNCAN: Oh, yes. Yes. And we listened in to, as Clint would call it, some of the sausage-making activities. Everybody had a lot of ideas, but how do you then narrow that down to the most important ideas that the Chileans could implement in a fairly rapid fashion? Even though at the time we were down there, they were estimating that it might be December before they were going to get the holes drilled for the miners to escape through, when you're already in September, December's not too far away. To develop a design from scratch and then build mockups and build prototypes and finally getting a final product, you don't have a lot of time to do that. Time really was of the essence, so there was a tremendous flurry of activity to get that report down to them.

Once the report was sent, we continued to have some contact. I had very little contact with the Minister of Health, for example, and any other officials down there. Dr. Polk continued

to have some contact with his medical counterpart, the submarine medical officer [Dr. Llarena]. Over the period probably over the next couple of weeks, that contact, in my recollection, died down fairly rapidly. Dr. Holland continued, I think, throughout the entrapment to have contact with his psychology counterpart [Dr. Iturra], but even the frequency of that contact was slowing down as this drug on and they got into a routine. By the time the miners were rescued in mid October, I don't know that there was a lot of active dialogue continuing. Once the report was sent, with regards to the engineering design suggestions, you'd have to double-check with Clint, but I don't believe there was a lot, or if any, dialogue with the Chilean naval yard that was actually doing the final design and build. The first time we saw pictures of it was just like everybody else did, on the news.

WRIGHT: From what I understand, quite a few of the recommendations that came from the group was adopted.

DUNCAN: Yes. Yes, very much so. The medical things that I mentioned with regards to communication with the miners, lighting, oxygen supply, compression stockings, fluid loading, all those things were done. From a pure engineering design requirement, if you look at the pictures, you can see these little wheels that are on the outside of it that are spring-loaded to help cushion and help reduce resistance as that thing was brought to the surface. Those were all design requirements that were suggested. So, yes, I think they did use a lot of them. It was very gratifying. Even though I say that, I think it's important to continue to note that all the final decisions were made by the Chileans, all of the design decisions, all the building, all the testing,

and it's really the Chileans that deserve all the credit and recognition for pulling off this whole rescue effort. I don't think we want to lose sight of that fact.

WRIGHT: I was going to ask you about your involvement with the Chilean Government as a whole. There were a number of reports talking about how much impact on the effort was sustained and, I guess, fostered just due to the fact that the top officials were involved with things that were happening on the ground. Then from what you said, you certainly were interfacing with so many of them. On October 13th, on the day that they began to bring them to the surface, I understand you were at the Chilean Embassy [in Washington, D.C.].

DUNCAN: I was.

WRIGHT: Tell us about that experience of being there.

DUNCAN: The Chilean Ambassador [Arturo Ferandois] was very appreciative of the fact that his country was able to make contact with NASA, and he came over and visited with the [NASA] Administrator [Charles Bolden] before the final decision was made to allow us to travel down there. He was very appreciative of the fact NASA had the willingness to get involved and to help them. After all the sixty-nine days had elapsed, it was very important to him to extend an invitation to NASA to have some folks come over. He also extended some invitations to folks from the State Department. I had the privilege of being over there that [Chilean Embassy] night, and it was an exciting night.

As I recall, the first miner was brought to the surface around 11 p.m. [EST] I got over there in the early evening, and it was just an exciting, electric kind of feeling that something good was going to happen. Of course, they had refreshments and hors d'oeuvres and a lot of people just standing around and talking.

They had a huge screen TV setup outside, on the front lawn of the embassy, and, of course, it's right on Massachusetts Avenue there [1732 Massachusetts Ave, NW]. They had a big spotlight, so it was daylight out there on the front lawn, even though it's 11 o'clock at night. There's music playing, and the Chileans were doing some dancing and they're going through this chant, "Chi-chi-chi-le-le-le!"

The Ambassador comes out and addresses the crowd and notes that I'm there and asks me to make some remarks, which I had no preconceived notion that that was going to happen. I talked to them about our experience and how warm and welcoming the Chilean people really were to us when we were down there, so it was great fun for me to be with them that night. Of course, when they did bring the first miner up, we were all just glued to that sight on the TV, and a tremendous roar went up, and more dancing and more music and more chanting. It was just a special time.

WRIGHT: I was thinking, as you were telling me about this journey, that you started out as the medical person at the Johnson Space Center. Now as you go through this effort, you now are representing Johnson Space Center, the Space Life Sciences area, the agency of NASA as a whole, as well as the United States Government. What an interesting personal journey for you and for us on the surface, it was a very short amount of time. Can you share with us what your

greatest challenge was working through all of this, taking on this responsibility where it just escalated from one phone call to an international effort?

DUNCAN: Right. There I was minding my own business in my office, and the phone rang. But it was an interesting journey. When you're not at Headquarters and you're at one of our Centers, you're really an operations-minded kind of individual, where at Headquarters you might be dealing more with programmatic issues or policy issues. I ran through the gamut of those different mindsets and the various stages of this activity, and it was quite interesting. It was an interesting journey personally as well as professionally. To be able to go down there and work, basically hand in hand with our colleagues in those conditions and understanding what the miners and the families were going through was very important.

Almost immediately, from my standpoint as being designated as the team lead, I was thrust in that mode of having to deal with officials, having to deal with the press, and the press was an international press corps. It was really quite amazing, the international interest in this story. I don't know how to describe how you manage that sort of thing. It just happened. We made the first call to the Ministry of Health on August 25th or so, and we were back from Chile by September 5<sup>th</sup>, so in those ten or eleven days, all of that transition occurred, in terms of my personal and professional experience with this. Then it continued at about the time of the rescue.

I don't know what else to say about that. Like I said, it just sort of happened. I think our agency leadership really believed in us and really didn't have us on a tight leash. They let us do what we felt was necessary. We were cognizant of what was at stake, not only the miners' lives, but the relationship of our agency with their space agency, the relationship of our government

with their government, the exposure that we were getting worldwide and what that meant for the agency. We work here because we believe in it.

WRIGHT: On an internal thought, how did you communicate back to the leadership here what was going on while you guys were down in South America?

DUNCAN: Every day we wrote a trip report, basically. I would type an email of the day's activities and send it back to Al Condes, and then he would distribute that to senior leadership. It was basically a travelogue, in a sense, where we went that day, who we met, what we talked about, what the plan was for the next day, and that's how we communicated for the most part. I don't remember if we communicated by phone to senior leadership. I think it was all done by email, but I don't remember for sure.

WRIGHT: Well, the leadership of the country appreciated your work too. I understand you were invited to the White House.

DUNCAN: We were.

WRIGHT: Can you share with us what that experience was like?

DUNCAN: Yes. This was on the 28th of October [2010], as I recall, about two weeks after the miners were rescued. Our team, as well as the [NASA] Administrator and then other people from the United States that helped with the rescue effort were also invited. [Brandon W.] Fisher,

the guy that designed the drill bit actually made contact with the Chileans saying something to the effect that, “Hey, I think I’ve got something here that will help you.” They were the Plan B drillers. He and his wife and some representatives from his company [Center Rock, Inc.] were there; the NASA team; the team that provided all the meals to the miners. Some 50,000-plus meals were provided to the miners over the course of their entrapment, so that team was there. Then in addition to the guy that designed the drill bit, the other hero in my mind is the guy that actually ran the rig [Jeff Hart]. He and one of his associates were in Afghanistan drilling water wells when they got the call, and they came to Chile and ran the rig.

There were fifteen or sixteen of us invited to the White House, and, of course, we all assembled there in the West Wing of the White House. After a few minutes of staging there, we were told that the President [Barack Obama] would see us, so they opened the door that leads down the corridor to the Oval Office, and the door to the Oval Office opens and the President is standing right there and is greeting each one of us as we enter. We were all lined up in a semicircle in front of his desk, and he spent about fifteen minutes with us that day, addressing us collectively and then going to each team to learn about who they were and what they did. Then we had an opportunity for photographs with the President, and, of course, all the time he’s addressing us, the White House photographers were snapping pictures.

When you think about the Oval Office and all the history that has taken place there over the years, to actually be there yourself is pretty neat, and I really wanted to take the whole thing in, so I’m looking around and I’m looking at the wallpaper and the furniture and the curtains. Then I always wondered what the President saw when he looked out the Oval Office window, so I took a glance out the window. Well, it was about that time that one of the White House photos was taken, and so you see the photo, all of us are looking towards the President, who’s

addressing one of the teams, everybody except me, however, and I'm looking out the window. I know it was just a fraction of a second that I glanced out there, but wouldn't you know it, they captured that on film. So that was one of the humorous parts of being there.

The President made us feel very welcome and like we were the most important thing on his calendar for that moment. There were a lot of other things going on in the world that day. In particular, that was the day that they discovered the explosive devices in the printing cartridges that were going to be transported on a cargo aircraft. The President has a big job, a lot on his mind, but he really made us feel very welcome while we were there.

WRIGHT: What are the plans for the team now? I understand that there's a possibility that the counterparts will be able to come together and exchange lessons learned as well as putting some closure to what happened.

DUNCAN: Since the rescue, we've really not had an opportunity to discuss much at all with our counterparts. We would like to be able to sit down and have a debrief opportunity. We're trying to make contact with our Chilean counterparts, working through the Chilean Space Agency and the Ministry of Health to try to set up a debrief. At one point, the Chileans had hoped to do some kind of a seminar where we would participate and talk about what transpired during the course of the entrapment of the miners. That's not been done yet. We're working on trying to put that together.

I think we need to be sensitive to what the Chileans want to do. While we at NASA are very accustomed to doing debriefs and lessons learned and writing this stuff down and then working forward for the next step, that may not be the same in their culture, and I think we just

need to be cognizant of their wishes as well, in terms of how they want to proceed, if they want to proceed. I think it'd be wonderful if we could invite some of our colleagues up here, primarily to Houston, where we could reciprocate a little bit in terms of showing them the [Johnson] Space Center and share with them part of our world as they've shared with us while we were down there.

WRIGHT: What do you believe that NASA has learned from this whole effort? What are the lessons learned so far that you know of?

DUNCAN: Since I don't know all the details of what they [the miners and our colleagues] actually did or went through, there's not a lot that's come back that we know about at this point, at least, that we could put to use for the human space flight business. That said, I think more globally NASA had the opportunity presented to it here to bring back to Earth some of the knowledge that we've gained from space flight. It may not necessarily be research knowledge, although in some cases it is, but certainly an operational knowledge of how to work with individuals in stressful environments. It's allowed us to bring the knowledge that we've developed back down on Earth to be utilized, and that's been part of our vision statement all these years, to not only go out and explore, but to help mankind here on Earth.

I think this was probably the first venture of its type that NASA got involved in, and I think it's a lesson for the agency to understand how well it is respected in the world, and we should feel good about that. Every circumstance is unique, and if something like that were to be presented again, we'd have to look at it critically, but sometimes there are good reasons to become involved.

WRIGHT: I don't want to end the session without asking you to talk about the end of the day. I know you have an event that you are going to be participating in. Would you like to share what that is?

DUNCAN: Sure. Today is August 3<sup>rd</sup>, 2011. August 5th will be the one-year anniversary of the entrapment of the miners, and the Chileans, with help from the State Department and the Smithsonian [Institution], are putting on a display at the Museum of Natural History that shows the actual Phoenix [Fenix] capsule. There will be other artifacts from the mine site, including rocks from the mine, as I understand it, and maybe some examples of the hardware, other hardware that was used, like the drill bit.

Tonight at the Museum of Natural History they're having a reception to inaugurate this display that will be open to the public on the anniversary date of the entrapment, August 5th. We're looking forward to going over there and seeing the artifacts and hopefully being able to see some of the people that we met when we were in Chile.

WRIGHT: Renewing friendships. I think J.D. Polk made that statement that you went down representing your country but came back as friends.

DUNCAN: Absolutely. That was a great comment and, I think, really captured what we were feeling at the time when we were down there.

WRIGHT: Is there anything else that you would like to cover or anything else you would like to add before we close for the day? I don't want to take your entire morning, but I certainly want to give you an opportunity.

DUNCAN: This has gone by very quickly here. I think we've covered it. There's probably little stories that would come to mind, but I think we've covered it in good detail.

WRIGHT: The only one I didn't cover that I was thinking about was regarding the headlines I was reviewing on how NASA was the reason why there was no booze or cigarettes [sent to the miners].

DUNCAN: Those are always the little questions that you can get tripped up on sometimes. I was asked that question at the very first press conference that we participated in at the Minister of Mining's office. The miners had apparently been making this request of tobacco products and beer or alcohol of our counterparts, and so far they hadn't provided them any.

At the first press conference that was one of the first questions that a reporter asked me about, did I think it was good for them to be given cigarettes and alcohol? Fortunately, I had the presence of mind to say something like, "Well, you know, this is early on in the rescue. We're still sorting out their health status and the effects of the environment and breathing in the dust, and their nutritional status. Once we understand their health a little better and get their nutrition up, but right now it wouldn't be a good idea." Then I think I also said something like, "I'm a lung doctor, a pulmonologist by training, and so I'm never too enthusiastic about recommending smoking."

As it turned out, as time wore on, I think they did provide them with cigarettes. I don't know about alcohol. Maybe. But, there comes a time when you have to balance what's important from a physical health standpoint against the psychological health standpoint. Smoking is pretty important in their culture, so at that point I think they made the decision that, well, if it's going to help us get through this thing, the benefits are going to be outweighed by the risks. And I think that was the right decision.

WRIGHT: I'm sure there were a number of those turning points. I think it was either J.D. or Al made the comment that everyone knew that you were on the right path when one of the desserts was sent back up.

DUNCAN: Oh, yes, exactly. We knew they were getting better when one of the miners sent a dessert back that he didn't like. And fortunately, the topside officials had enough insight as well to say, "We need to maintain some control here. We can't have mutiny." So they sent the dessert back down and said, "That's what we've got for the day. We'll try to do better."

WRIGHT: A little tough love there.

DUNCAN: Yes, exactly.

WRIGHT: I did think of one other thing. The triage effort, because you were at the [Chilean] Embassy when they were coming up, you actually got to see some of the plans that you had

helped put in place. Could you share with us how well you felt that worked or how it worked for them as you were watching that all unfold?

DUNCAN: When they brought the miners to the surface, I think all of us watching were impressed by really how good those guys looked, at least visually on camera. To think that they'd been entrapped that long underground in those miserable conditions down there, they really looked pretty healthy.

Of course, there's the initial celebratory moment and you can't ignore the fact that their President was standing right there, and deserved a hug and a handshake and time for some emotional release, but then they were put on gurneys. Of course, they were wearing the sunglasses because we were concerned about, especially if they were brought up in daylight, the ultraviolet light irritating the eyes, almost like a snow blindness. We saw those preventive aspects. We saw that they were pulled into a triage area that was kept out of view of the camera, and after a period of stabilization, then they were transported to the hospital.

So, yes, it was quite gratifying to see. I can remember standing on the hillside there, and J.D., who, as I said, is an expert in critical-care transport, with a lot of flight hours in helicopters managing patients, and he's talking to them about, "This would be a good spot for a helipad and they could go down in the valley and fly out that way," and talking about triage areas and places where more in-depth medical treatment could be provided at the mine site and yet have some privacy for initial family greeting. It was very interesting to see all that and to remember the conversations that we had about that along the way.

WRIGHT: I thank you for your conversation today, and look forward to learning more about what you learn.

DUNCAN: Thank you.

WRIGHT: Thank you.

[End of interview]