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13:43:06:14 MS: Thank you. I want to begin by saying that the problem of global warming and climate change is real. The basic science has been well known for 100 years, there hasn't really been a climate science in this country except for the last couple of decades, there was meteorology and there was geography, but most of the people who are concerned now with climate and climate change, are people from different disciplines who discovered in the last 20 years that they are part of the subject of climate science, the atmospheric chemist, the atmospheric physicist, the meteorologist, the agronomist, the marine biologist, all found in the last 20 years that they have something to contribute to this subject.

13:43:51:20 It's essentially a new subject and it is still a growing subject. This morning's newspaper tells us that there are some new estimates of... what the likely temperature change maybe the end of the century. It's a growing subject but the basic idea is there. It's been known for 100 years that Mars is too cold for water to exist as a liquid because it has no greenhouse atmosphere.

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13:44:24:18 And Venus is too hot for water to exist as a liquid because it has too much greenhouse gas. Earth is the only planet in our solar system that has a combination of carbon dioxide and water vapor to keep the planet warm enough so that it's not frozen solid and cool enough that the water hasn't all evaporated. It's furthermore been known that if you shine an infrared light through a chamber full of carbon dioxide, less comes out of the other end than went in and the difference is perfectly correlated with the rise of temperature of the carbon dioxide in the chamber through which the infrared was shined.

13:45:03:06 This has all been understood and there's no dispute about the basic science. We're talking really about climate change not global warming because in fact I should say climates change. There are hundreds of climates around the world, different from each other and they're likely to change in very different ways. Some get hotter, a few will get cooler, some will get cloudier, some will get sunnier, some will get more storms, some will get fewer storms, some will suffer drought, some will suffer flooding.

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13:45:40:27 And it's a very complicated issue because climates differ between East Coasts and West Coasts of continents and it's even interesting the, very little is known about what kind of climate change will occur above 3000 meters. Well only a few Tibetans and Bolivians live above 3000 meters, but what happens up there is crucial to agriculture in China, India, Peru, Chile, Argentina, California, Colorado because much irrigation of agriculture around the world depends on snow that falls in the winter in the high mountains and melts gradually beginning in late spring and through the irrigation season of the summer.

13:46:26:23 And if what happens above 3000 feet is of what used to be snow falls as rain, it's lost, unless you have a huge infrastructure to capture it. And if it falls as snow but melts too early in the spring, it's unavailable for irrigation because it's already flown down river to the oceans so that climates are a complicated issue and even understanding the difference between climate in the high Andes and climate in the Himalayas is still a matter of great uncertainty.

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13:47:01:24 So this is a brand new subject and it's not surprising that there are huge uncertainties. The biggest uncertainty I believe is what kind of societies are going to exist in the second half of this century, the societies on which the climate change that is predicted is going to be superimposed. It's very easy to think about climate change being superimposed on us now, the way we work, the way we live, the way we entertain ourselves and the way we take our recreation, the plants like to grow in our gardens and all of that.

13:47:33:03 But the climate change is primarily going to be superimposed on the way people live and work in the second half of this century. And if you imagine back in the 1920s, predictions of climate change over the coming 75 or 100 years, predictions of the kind that are now being made about climate change for the next 75 or 100 years, it's hard to imagine what people would have thought back in the 1920s.

13:48:02:14 I think it's clear that people would have been much less concerned about hotter summers than about warmer winters. I think people in the United States would

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have been very much concerned with what's going to happen to roads. How much mud will there be, how much snow there will be? Back in the 1920s automobile tires were about two and a half inches in diameter, pumped up to 60 pounds per square inch.

13:48:28:00 They were as hard as wood and one of the worst problems in the summer was mud because cars couldn't travel in mud. One of my uncles made a lot of money every summer by taking a team of horses down to pull automobiles out of the, the mud holes in the road near his house. And I, I think that... trying to imagine not only for the United States, but for a country like India or Sub-Saharan Africa, how people are going to be earning their livings, how they're going to be living, how they're going to be entertaining themselves and what kind of recreation they will take, is, is a big source of uncertainty.

13:49:08:00 I think the one thing we know for sure is that the worst damages are going to occur to the poor countries, the ones we call the developing countries, not all of which are actually developing. And the reason is largely because they are so much dependent

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on outdoor activity, especially agriculture.

Agriculture in the United States and agriculture in most of the developed world, whether it's France, Germany, Japan, Israel, Norway, most agriculture is less than five percent of the national income of the gross domestic product.

13:49:45:08 In the United States it's about two and a half or three percent. Whatever happens to agricultural productivity, the Americans are probably going to be well enough to do, to afford higher priced food. And probably American farmers of whom there are very few who depend on agriculture. You know the Census Bureau no longer counts... family farms, there aren't enough to be worth counting.

13:50:15:07 But at least if the cost of food goes up, the... the people who will suffer are the poor... and the Americans, by the time all of this happens, are likely to have doubled the per capita income anyhow. And the important thing is that the developing world is extremely vulnerable to climate change. And the best hope for their defense against climate change is going to be their own development.

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13:50:44:01 Becoming less dependent on subsistence agriculture and... and less subject to the health problems that go with poverty. I'll give you an example. Singapore and Malaysia are separated by a kilometer of seawater. Forty-five years ago they were the same country, they have identical climates. Singapore has fantastically developed in the last 45 years until it has just about the highest standard of living in the world.

13:51:16:02 Malaysia has developed but nothing like Singapore. There's no malaria in Singapore, there is lots of malaria in Malaysia, that's partly because Singapore, being a small, compact rich country, can have anti-mosquito programs, but it's also because Singaporeans are well fed, they're healthy, they have a good health infrastructure, good medical care, good hospitals.

13:51:42:11 If a Singaporean gets malaria it's because he or she spent the weekend in Malaysia and got bit by a mosquito and came back, but because their healthy to begin with and well fed, malaria is not life-threatening in Singapore the way it can be in Malaysia. So that I want to stress is that the... the

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most endangered countries from the point of view of climate change, are in the developing world and, this is crucial, their best defense against climate change is their own development.

13:52:17:02 I mention that because it's important not to demand of the developing countries, that they try to undergo... drastic transformations of their energy sector, for the sake of slowing climate change, because anything that slows down their own development... will worsen their situation as climate change occurs. And I mention that to introduce the subject of my talk which is, it's going to very important to get at least major developing countries, China, India, Brazil, Indonesia and a few others, to get them to participate actively in changing their sources of energy in order to help slow down the, the earth's warming and climate change.

13:53:15:28 This has been on the minds of people concerned with this subject for a long time, in fact, at the time of the Kyoto Conference in 1997 which was a conference in Kyoto that led to a draft treaty about climate change, the US Senate passed unanimously a resolution to the effect that they would not consider ratifying any kind

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of climate treaty in which the main major developing countries were not full participants, whatever full participation meant.

13:53:50:12 Bill Clinton then said, as President, that he would not submit the treaty to the Senate for ratification... until diplomacy had brought China and India and other major developing countries into compliance with the Kyoto kind of program. And... the Clinton Administration did nothing. Then we had for eight years a President who either didn't believe in climate change or pretended not to believe in climate change.

13:54:26:08 I think we now have a President who does believe in it and who takes it seriously and the Congress is beginning to take it seriously. So I think there's hope that something can be done, I am not optimistic that anything serious is going to come out of the Copenhagen Conference in December. I think... the Copenhagen Conference would be a great place to display to the public... a negotiated agreement that had been worked out over the preceding six, eight, or ten months.

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13:55:02:11 But I don't think much can be accomplished in 10 days or two weeks in Copenhagen, but it may stimulate continued interest in the subject and... I think it's too early to despair. But the one thing that I believe isn't going to get any attention in Copenhagen because I don't think there's really any serious work on this going on, is how the rich countries can help the main developing countries transform the way they produce and utilize energy.

13:55:41:28 It's going to be required for China, India, Brazil and others, if we want them to, to drastically transform their energy sectors by either putting some of the results of their electric power smokestacks underground, permanently or developing wind power, solar power, converting from coal to oil or natural gas and other ways. It's going to require help from the rich countries to get them to do it.

13:56:15:08 And the problem is I can't find who's working seriously on how the countries that can afford to do it can transfer resources to the developing world to help them participate in a program to reduce the

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emission of greenhouse gases, particularly carbon dioxide which results from the burning of coal, oil and natural gas.

13:56:45:06 What's going to be required eventually is somehow for the rich countries whoever they are, to negotiate how they will share and contributing resources to the developing world. By the rich countries I mean a large part of the European Union, the United States, Canada, Japan, Australia, New Zealand, probably not Russia. There needs to be some way that these countries can agree on how much they will put up to help the developing world and how they will share the costs of transferring resources for the developing world.

13:57:29:15 This is not the kind of thing that the developed countries have engaged in, at least not in the last 50 or 60 years. I think we're also going to need some kind of institution... within which the major developing nations that are important for the greenhouse problem, China, India, Brazil, Indonesia and a few others, how they can decide or have it decided for them, but I prefer they decide, how they

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will share in whatever resources are going to be available to transform their energy sectors.

13:58:11:27 And what they will commit themselves to do in return for the kind of help they may get. I think then there's also going to be needed a third institution and intermediary between the donor countries and the receiving countries. I think it's a bad idea to have individual rich countries bilaterally working with individual developing countries.

13:58:40:24 Lately people have referred to something known as the G2, it's meant to mean the United States and China. I, I think the worst thing would be to think that the countries like the United States and China might get together and talk about bilateral relations in connection with the greenhouse problem. The United States has enough trouble dealing with China with respect to North Korea, Taiwan, the exchange rate, civil liberties and all of those things.

13:59:09:15 And to get all of that mixed up with a negotiation over how much financial resources to be transferred from the United States to China, I think would

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simply... dirty up the greenhouse gas negotiations by getting it all entangled in all the other things that are at stake between the United States and China. So I think there needs to be an intermediary institution so that there are no bilateral relations, but the rich countries will channel funds into the developing world by way of some kind of institution.

13:59:46:02 The World Bank comes to mind as a possible intermediary. I don't know enough about how the World Bank, how its relations are now with the developing world, what their... it really is the institution to do that. It has so many other responsibilities besides dealing with climate change, that I, I think maybe we will need a new institution specialized for the purpose of... transferring the funds and monitoring their use and verifying that they are used the way they were supposed to be used.

14:00:24:11 I, I tend to think that state financial transfers are not the way to go. Transferring money from a combination of rich countries to a combination of poor countries is going to look very much like either bribery or extortion. And, and I think it's important

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that the... the transfer should be in the form of investing in specific projects that relate to the energy problem, to the greenhouse problem.

14:01:02:25 I can't think of any precedent in the last 50 years for what is going to be needed. During the early years of the Marshall Plan, beginning in April of 1948, the United States first contributed \$5 billion for a 15 month period to the 15 countries of Western Europe that were part of the organization for European Economic Cooperation.

14:01:29:19 That was \$4 billion was about two percent of the US gross national product, that was a lot of money. And the United States divided it up among the recipient countries of Western Europe. For the second year, for '49, '50, the United States said, we will appropriate a lump sum and you will divide it among yourselves. That was quite a challenge, the OEEC, the Organization European Economic Recovery, had to develop detailed questionnaires that every recipient nation would fill out in order to indicate how it was qualified for how much aid it was requesting out of the total that might be forthcoming.

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- 14:02:22:17 And this involved making up national accounts which was something that was brand new in the United States and no economist in Greece knew anything about national accounts and they had to be, they all had to learn how to put together a national accounts. They had to identify how they were going to devote their gross national product, including any imports under the Marshall Plan.
- 14:02:44:24 How they were going to divide up between public investment, private investment, private consumption, what the investment would be, whether it be repairing roads, railroads and dredging canals or building schools and homes and hospitals. What, what they would be investing in, how they would ration gasoline and meat and butter and all of those things.
- 14:03:06:20 And they spent six months developing this program which was essentially a claim for a part of the resources that the US would make available. And then at the ministerial level in Paris, they negotiated for about six weeks, cross-examining each other, because more for one country was less for the rest of them.

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And they negotiated peacefully on a first name basis, in good, good will and almost reached agreement.

14:03:35:04 Finally the Secretary of the OEEC, Secretary General of the OEEC, a very respected economist, and the Belgian delegate, Belgian was not asking for any portion. The two of them went off to Fontainebleau on the outskirts of Paris and spent a weekend... preparing a proposal for how to share the funds among the 14 countries that were asking for funds, how to share them.

14:04:00:09 They came back, presented it to the ministers of the 14 countries and it was, the division was immediately and unanimously accepted. It's the only precedent I've ever been able to find for countries getting together and... in gentlemanly fashion, negotiating how to share a crucially large lump sum of resources that was available only if they could find a way to divide it among themselves.

14:04:38:28 And... I tend to think, but I can't be sure, that the best way to divide whatever aid is going to be available to the developing world, the best way is to

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have identified potential recipients negotiate among themselves. They may not be able to agree, after all, India and China were at war barely 45 years ago and they still have military confrontations in the, in the Himalayas.

14:05:09:21 But I think if they can be induced to... make the division by negotiating among themselves, that's the best way to go. Now, have contributing countries ever agreed on how to share in contributions... there were few precedents, again 50 or 60 years ago. In 1951 when the Marshall Plan was converted into the Mutual Security Program and aid was available to European countries, largely in relation to the burdens they would share in NATO defense.

14:05:52:22 In 1951 all the American aid was to be available only in connection with commitments that the recipient countries would undertake. These were commitments, how many young men they would raise for the armed forces, for how many months they would train them, for how many months or years they would serve? How much of their budgets they would spend on military equipment and ammunition?

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14:06:20:21 How much real estate they would make available for military maneuvers, for... NATO pipelines, for military housing and things of that sort? How many of the young men they drafted would be available to serve in Germany? And again they went through something like what had happened with the Marshall Plan division in 1949, '50, it was called the Bergman Sharing Negotiation.

14:06:45:13 It took place in Paris and eventually three people, one of whom was US Ambassador Averill Harriman, went off to... Versailles or some such place, spent a weekend proposing how the aid would be divided in return for specific military commitments from all the countries.

14:07:07:00 And again, there was agreement once this was proposed to them. And interestingly, in huge contrast to a lot of... treaties that had been undertaken, the countries incurred military commitments in 1951, partly in response to US aid that was available. They virtually all kept those commitments and I think one difference between what NATO involved and what most... climate

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treaties tend to involve, the NATO countries committed themselves to what they would do, not to what, what the results would be 20 or 30 years down the road.

14:07:54:04 The Dutch didn't say, we will contribute to retarding a Soviet invasion by two and a half days. And the French didn't say, we will contribute enough to reduce the likelihood of a Soviet attack by two and a half percent. No, they committed themselves to the troops they would raise, the money they would spend, the real estate they would make available and all of those things.

14:08:16:07 And therefore they knew whether they kept their commitments and everybody else knew whether they kept their commitments because you could look and see what they were doing. I think that suggests to me strongly that... a treaty or an agreement on what to do about reducing greenhouse gas emissions is better oriented toward the actions that will be taken than the results in the year 2030 or 2050.

14:08:45:26 To say that we will reduce greenhouse gas emissions by 50 percent by 2030 or by 80 percent by 2050... doesn't

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indicate what is going to have to be done, so nobody can tell along the way whether what is being done is compatible with the, the ultimate goal. Also we have precedents that the Brenton Woods negotiation in 1946 which established the International Bank for Reconstruction and Development and the International Monetary Fund, required contributions to the capital assets of those two institutions.

14:09:23:25 They both, both institutions had to be in the business of selling bonds in the market to accumulate funds and then lending out the funds for reconstruction and development. And they needed some capital assets and the capital assets had to come from the countries who could afford to contribute and there had to be a negotiation to determine how much and in what currencies, the, the various contributing countries would make their contributions.

14:09:52:05 Well, they managed to arrive at agreement, I won't try to describe the formulae, they weren't really formulae they were negotiated shares. But the IMF and the World Bank did get funded and established and have been in existence and in working form more than half a

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century. The UN budget required some way of sharing costs.

01:41:00:16 The League of Nations had the same problem after the First World War and they looked around to find that the International Postal Union of 1874 had had a way of so to speak, taxing the participants for shares in the funds that were needed by the International Postal Union. It turned out to be a ridiculous system and the League of Nations couldn't find any other system to copy, so they copied it.

14:10:38:05 And then they tried to get out of it. The United Nations after the Second World War... tried to establish something analogous to a progressive income tax so that the share of GNP that each country would contribute for the UN budget would be higher for countries with higher per capita incomes. And it sort of turned out that way except that the UN had a special problem which was that the United States was such a huge part of the world economy, that almost any reasonable formula would require the United States to contribute more than half of all the funds.

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14:11:12:13 And the United States found that unacceptable and most other countries felt that that would be a dominating or domineering situation for the United States to be in. And so I think they ended up with the United States share be something on the order of slightly more than one, one-third of the total. But they also have separate negotiations because whenever there are specific programs like peacekeeping programs, depending on the na... the country in which the peacekeeping is going to happen and the countries that are contributing peacekeeping personnel, there are different countries negotiating shares of the costs of whether they are peacekeeping in a, in a place like the Congo or peacekeeping in... in a Southeast Asian country.

14:12:03:04 And there was a, a negotiation under the United Nations right after the war for the United Nations Relief and Rehabilitation Program in which an effort was made to find an appropriate formula for the sharing of those nations that would contribute to the United Nations Relief and Rehabilitation Program. And the negotiation ended up with the idea that every

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contributing nation would contribute one percent of a year's national income.

14:12:34:06 And I think the one percent illustrates an important point, whenever you're negotiating you tend to settle on some... critically unique formula that couldn't be a rounder number than one percent. And it turned out that while they agreed on that, most of the countries didn't put up the one percent and the United States ended up contributing three-quarters of the total because somebody had to and the United States was in the position to do it.

14:13:15:07 So I think we're going to need some kind of institution within which the contributing nations can negotiate how much they will contribute and in what shares they will do it. We're going to need an institution in which the recipient developing countries of whom there maybe anywhere from six to a dozen, I don't quite know how many will be considered crucial for the climate purpose.

14:13:42:24 And the institution whereby the can at least attempt to reach an agreement on how they would share what's

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available. Then I think we will need an intermediary agency that will monitor what is done with all of the funds and, and monitor actually monitor an entire climate-oriented investment program in each recipient country because there's no sense in... in simply financing one or two particular investments that simply substitute for what the country itself might have done.

14:14:18:04 So I think that what's going to be required is that the recipient countries must have a coherent program of what they will be doing with respect to their energy sector. And then within that, there can be identification of these internationally transferred funds to specific projects. Now what are those projects likely to be?

14:14:40:07 I don't have much more time to talk to you, but I think... they're probably going to be many investments required in a country like China or India, large investments. I will name some, one interestingly, the latest issue of "The Journal Science" carries maps, some maps of China indicating where in China there is a lot of wind power.

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14:15:15:09 Wind power is an attractive source of energy, source of electricity because it doesn't involve any greenhouse gas emissions, but wind power depends on where the wind blows and it has to blow fairly regularly. And... and it also has to blow not too far away from where the electricity is going to be used because transmission of electricity costs something, especially if you have to transmit the electricity a few thousand kilometers.

14:15:45:22 But it looks as if China has some exceptional capacity for wind energy, especially in northeast China and Manchuria. It has a lot of good wind in Chinese occupied Tibet, but Tibet is a long way from where they need the electricity so that's not going to be so helpful. But at least if funds were available to help China reduce its dependence on coal, wind power looks to be, at least in that country, as one good way to go.

14:16:17:07 China is also known to be fairly advanced in developing direct conversion of sunlight into electricity and... and that would require huge

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installations, requiring lots of investment. There is recently a lot of interest in capturing carbon dioxide as it's emitted... how many more, two things, okay. Carbon capture and sequestration, you're going to hear a lot about this.

14:16:48:10 This is a way of taking the carbon oxide that comes out of a smokestack, separating it from the rest of the gases, converting it into what they call the super critical form which is sort of like a liquid, transporting to where it can be injected underground, deep underground, and, and kept there. This has been done for 30 or 40 years because putting carbon dioxide underground and depleting oil wells helps get more oil out of the depleting oil wells.

14:17:21:10 So that the technology for capturing and removing the carbon dioxide from a large electric power plant is there, but no everybody cared how long it stays down there. And you've got to find places where the carbon dioxide will stay for at least a couple of hundred years. And this is, this is something that could make a huge difference. China, India, Russia, the United

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States and Secretary Chu, our Secretary of Energy, is very much interested.

14:17:49:19 And this is going to require huge investments and it could mean that China, which has enormous coal deposits and is building a coal fired electric power plant at the rate of more than one every week, this could mean that China can exploit its valuable coal resources by separating out much of the carbon dioxide and injecting it underground and sealing it in.

14:18:15:15 But that's going to require a lot of geological exploration and experimentation. And, and eventually it's going to be an expensive process because you have to build a whole plant for the purpose of capturing the carbon dioxide and then you have to build the pipelines to get it to work, inject them underground. So I think there are a lot of ways to make investments that would at least look as if the resources being transferred are being helpfully applied to reducing carbon dioxide emissions.

14:18:48:10 And... now my question is, where does the initiative for all of this come from? Who is working on this? I

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do not get the impression that... there is a well-identified part of the US Government that is thinking about how to establish the institutions that will allow the rich countries to get together and agree on how they will contribute.

14:19:21:27 And there's no, I don't know who's working on the question, how do we identify the appropriate recipient countries and who's to host some kind of negotiation among them? And I don't know who's thinking about whether the World Bank has other things to do then intermediate in this resource transfer. So if any of you know who's working on it or know that nobody's working on it and have suggestions of how to get the United States Government focused on this, I don't know whether in any other governments that's focused on this.

14:19:59:07 But, but I keep my eyes open, I read "Science and Nature" and "Scientific American" and the "Economists of London" and "The Atlantic Monthly" and of course "The New York Times" and "The Washington Post" and I never hear about anything being doing along these lines. But eventually, eventually if we're going to

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take care of the climate problem, we're going to have to find ways to make it possible for China and a lot of other countries to participate in an expensive program of transforming their energy economies in a way that does not cripple their own development.

14:20:40:08 Thank you.

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